JUNE • 1947
VOLUME XVIII NUMBER 9

the Petroleum Engineer

...ds for Operating Men

MEETINGS

June 23-25—American Chemical Society, regional meeting, Kansas City, Mo.
June 25—API production division, Rocky Mountain district, Mammoth Hotel, Yellowstone National Park.
June 26-27—Rocky Mountain Oil and Gas Assn, Mammoth Hotel, Yellowstone Park.
July 7-8—Michigan Gas Assn, Grand Hotel, Mackinac Island.
July 18—Nomads annual "Whing-Ding", Riveria Country Club, Los Angeles, Calif.
Aug. 11-13—Interstate Oil Compact Commission, Rainbow Hotel, Great Falls, Mont.
Aug. 25-27—Appalachian Gas-Measurement Short Course, School of Mines, West Virginia University, Morgantown.
Sept. 1-4—ASME, fall meeting, Hotel Utah, Salt Lake City.
Sept. 8-12—Instrument Society of America, conference and exhibit, Hotel Stevens, Chicago, Ill.
Sept. 10—Nomads, Jonathan Club, Los Angeles, Calif.
Sept. 15-17—Nat'l Butane-Propane Assn, annual meeting, Jefferson Hotel, St. Louis, Mo.
Sept. 17-19—National Petroleum Assn, annual, Hotel Traymore, Atlantic City, N. J.
Sept. 23-25—Pacific Coast Gas Assn, Coronado Hotel, San Diego, Calif.
Sept. 29-30—IPAA, annual meet, Okla. City.
Oct. 7-8—American Gas Assn., annual meeting, Cleveland, Ohio.
Oct. 8—Nomads, Jonathan Club, Los Angeles, Calif.
Oct. 8-10—AIME, Petroleum Division, Mayo Hotel, Tulsa, Okla.
Oct. 10—California Natural Gas Assn, Fall meet, Ambassador Hotel, Los Angeles.
Oct. 13-15—American Assn of Oilwell Drilling Contractors, annual, Long Beach, Calif.
Oct. 16-17—Texas Mid-Continent Oil and Gas Assn, Gunter Hotel, San Antonio.
Oct. 16-18—National Lubricating Grease Institute, Edgewater Beach Hotel, Chicago.
Oct. 21-25—American Chemical Society, Pacific Chemical Exposition, Civic Auditorium, San Francisco, Calif.
Oct. 23-24—AIME, Petroleum Division, Elks Club, Parkview Street, Los Angeles, Calif.
Nov. 6-7—SAE, Fuels and Lubricants meeting, Hotel Mayo, Tulsa, Okla.
Nov. 10-13—API, annual meeting, Stevens Hotel, Chicago, Ill.
Dec. 1-5—ASME, annual meeting, Chalfonte and Haddon Hall, Atlantic City, N. J.
Jan. 12-16, 1948—SAE, annual meeting, Book-Cadillac Hotel, Detroit, Mich.
April 6-7, 1948—Western Petroleum Refiners Assn, annual meeting. Galvez and Buccaneer Hotels, Galveston, Texas.
May 4-5, 1948—American Gas Assn, Rice Hotel, Houston, Texas.
May 15-22, 1948—International Petroleum Exposition, Tulsa, Okla.

DRILLING AND PRODUCTION

Thermal Surveys Applied to Oil Field Problems—Henry G. Abadie 47
X-Ray Oil Field—From Laboratory 53
Selection of Mud Fluid for Completion of Wells—H. E. Radford 72
Control of Unconsolidated Sands in Wilmington Oil Field—Read Winterburn . 80
Formation Logging—Richard E. Gile 93
Diamond Core Drilling Methods and Problems—Carroll Deely 98
Developments in Casing Standards and Design—John Wais, Jr. 106
Economics of Dual Wells in Waskom Field—K. Marshall Fagin 120
The Dry Ice Man Cometh 129
Control of Mud Properties in Drilling Anhydrite—George R. Gray 142
The Determination of Stresses in Oil Well Casing in Place—C. H. Oberg and R. W. McMasters 149

REFINING AND NATURAL GASOLINE MANUFACTURE

Cycling Plant Includes Innovations—Frank H. Love 41
Hydrocarbon Absorption and Fractionation Process Design Methods (Part 2)—Wayne C. Edmister 57
Magnolia's New Vanderbilt Gasoline Plant—H. L. Baker 131
Remodeling Richmond Refinery "Long Wharf" 166

OIL AND GAS TRANSPORTATION

Selecting Storage Tanks for Pipe Line Service—D. A. Leach 49
United Completes Mississippi Pipe Line—O. C. Irvine 113
New Pipe Cutter Designed and Built—Claribel Thompson 184

GENERAL

How to Operate a Small Boiler—W. F. Schaphorst 48
New Plant to Manufacture Alkyd Resins 86

REGULAR FEATURES

The Course of Oil 12
Scanning Washington's Oil Horizon 14
National Petroleum Situation 16
Highlights in Oildom 18
Current Oilfield Operations 20
Pipeline Developments 22
Refining and Natural Gasoline Activities . 24
Machinery and Equipment 171
Trade Literature 180
The Petroleum Engineer's Continuous Tables (Installment No. 120) 187
Running Tour With Men in the Industry 203
Crude, Cracked and Volatile 208
Pacific Personalities 228
Book Reviews 231

THE PETROLEUM ENGINEER PUBLISHING COMPANY
Irwin-Keasler Building, Dallas 1, Texas **Phone:Central-4571**

EXECUTIVE—W. L. LOVE, *president*. W. T. BRYAN, *general manager and treasurer*.
EDITORIAL—K. C. SCLATER, *vice president and editor*.
FRANK H. LOVE, *managing editor* ERNESTINE ADAMS, *associate editor*
K. MARSHALL FAGIN, *field editor* REMY LAWSON, *editorial assistant*
RICHARD SNEDDON, *Pacific coast editor*, 653 West Glenoaks, Glendale 2, Calif., Citrus 2-8446.
ADVERTISING—T. J. CROWLEY, *vice president and advertising manager*.
New York—JOE B. WOODS, 52 Vanderbilt Avenue, New York 17, N. Y., MUrray Hill 4-1880.
Chicago—E. V. PERKINS, 22 West Maple Street, Chicago 10, Illinois, SUperior 1823.
Los Angeles—RICHARD P. McKEY, 2024 West Sixth Street, Los Angeles 5, FAirfax 1127.
CIRCULATION—C. R. BARRETT, *circulation manager*.
Copyright 1947 by The Petroleum Engineer Publishing Company
Articles in The Petroleum Engineer are indexed by Industrial Arts Index
A. B. C. SUBSCRIPTION: 1 year, $2 — 2 years, $3 A. B. P.

JUNE • 1947
VOLUME XVIII NUMBER 9

the Petroleum Engineer

...ds for Operating Men

MEETINGS

June 23-25—American Chemical Society, regional meeting, Kansas City, Mo.
June 25—API production division, Rocky Mountain district, Mammoth Hotel, Yellowstone National Park.
June 26-27—Rocky Mountain Oil and Gas Assn, Mammoth Hotel, Yellowstone Park.
July 7-8—Michigan Gas Assn, Grand Hotel, Mackinac Island.
July 18—Nomads annual "Whing-Ding", Riveria Country Club, Los Angeles, Calif.
Aug. 11-13—Interstate Oil Compact Commission, Rainbow Hotel, Great Falls, Mont.
Aug. 25-27—Appalachian Gas-Measurement Short Course, School of Mines, West Virginia University, Morgantown.
Sept. 1-4—ASME, fall meeting, Hotel Utah, Salt Lake City.
Sept. 8-12—Instrument Society of America, conference and exhibit, Hotel Stevens, Chicago, Ill.
Sept. 10—Nomads, Jonathan Club, Los Angeles, Calif.
Sept. 15-17—Nat'l Butane-Propane Assn, annual meeting, Jefferson Hotel, St. Louis, Mo.
Sept. 17-19—National Petroleum Assn, annual, Hotel Traymore, Atlantic City, N. J.
Sept. 23-25—Pacific Coast Gas Assn, Coronado Hotel, San Diego, Calif.
Sept. 29-30—IPAA, annual meet, Okla. City.
Oct. 7-8—American Gas Assn., annual meeting, Cleveland, Ohio.
Oct. 8—Nomads, Jonathan Club, Los Angeles, Calif.
Oct. 8-10—AIME, Petroleum Division, Mayo Hotel, Tulsa, Okla.
Oct. 10—California Natural Gas Assn, Fall meet, Ambassador Hotel, Los Angeles.
Oct. 13-15—American Assn of Oilwell Drilling Contractors, annual, Long Beach, Calif.
Oct. 16-17—Texas Mid-Continent Oil and Gas Assn, Gunter Hotel, San Antonio.
Oct. 16-18—National Lubricating Grease Institute, Edgewater Beach Hotel, Chicago.
Oct. 21-25—American Chemical Society, Pacific Chemical Exposition, Civic Auditorium, San Francisco, Calif.
Oct. 23-24—AIME, Petroleum Division, Elks Club, Parkview Street, Los Angeles, Calif.
Nov. 6-7—SAE, Fuels and Lubricants meeting, Hotel Mayo, Tulsa, Okla.
Nov. 10-13—API, annual meeting, Stevens Hotel, Chicago, Ill.
Dec. 1-5—ASME, annual meeting, Chalfonte and Haddon Hall, Atlantic City, N. J.
Jan. 12-16, 1948—SAE, annual meeting, Book-Cadillac Hotel, Detroit, Mich.
April 6-7, 1948—Western Petroleum Refiners Assn, annual meeting. Galvez and Buccaneer Hotels, Galveston, Texas.
May 4-5, 1948—American Gas Assn, Rice Hotel, Houston, Texas.
May 15-22, 1948—International Petroleum Exposition, Tulsa, Okla.

DRILLING AND PRODUCTION

Thermal Surveys Applied to Oil Field Problems—Henry G. Abadie 47
X-Ray Oil Field—From Laboratory 53
Selection of Mud Fluid for Completion of Wells—H. E. Radford 72
Control of Unconsolidated Sands in Wilmington Oil Field—Read Winterburn . 80
Formation Logging—Richard E. Gile 93
Diamond Core Drilling Methods and Problems—Carroll Deely 98
Developments in Casing Standards and Design—John Wais, Jr. 106
Economics of Dual Wells in Waskom Field—K. Marshall Fagin 120
The Dry Ice Man Cometh 129
Control of Mud Properties in Drilling Anhydrite—George R. Gray 142
The Determination of Stresses in Oil Well Casing in Place—C. H. Oberg and R. W. McMasters 149

REFINING AND NATURAL GASOLINE MANUFACTURE

Cycling Plant Includes Innovations—Frank H. Love 41
Hydrocarbon Absorption and Fractionation Process Design Methods (Part 2)—Wayne C. Edmister 57
Magnolia's New Vanderbilt Gasoline Plant—H. L. Baker 131
Remodeling Richmond Refinery "Long Wharf" 166

OIL AND GAS TRANSPORTATION

Selecting Storage Tanks for Pipe Line Service—D. A. Leach 49
United Completes Mississippi Pipe Line—O. C. Irvine 113
New Pipe Cutter Designed and Built—Claribel Thompson 184

GENERAL

How to Operate a Small Boiler—W. F. Schaphorst 48
New Plant to Manufacture Alkyd Resins 86

REGULAR FEATURES

The Course of Oil 12
Scanning Washington's Oil Horizon 14
National Petroleum Situation 16
Highlights in Oildom 18
Current Oilfield Operations 20
Pipeline Developments 22
Refining and Natural Gasoline Activities . 24
Machinery and Equipment 171
Trade Literature 180
The Petroleum Engineer's Continuous Tables (Installment No. 120) 187
Running Tour With Men in the Industry 203
Crude, Cracked and Volatile 208
Pacific Personalities 228
Book Reviews 231

THE PETROLEUM ENGINEER PUBLISHING COMPANY
Irwin-Keasler Building, Dallas 1, Texas **Phone:Central-4571**

EXECUTIVE—W. L. LOVE, *president*. W. T. BRYAN, *general manager and treasurer*.
EDITORIAL—K. C. SCLATER, *vice president and editor*.
FRANK H. LOVE, *managing editor* ERNESTINE ADAMS, *associate editor*
K. MARSHALL FAGIN, *field editor* REMY LAWSON, *editorial assistant*
RICHARD SNEDDON, *Pacific coast editor*, 653 West Glenoaks, Glendale 2, Calif., Citrus 2-8446.
ADVERTISING—T. J. CROWLEY, *vice president and advertising manager*.
New York—JOE B. WOODS, 52 Vanderbilt Avenue, New York 17, N. Y., MUrray Hill 4-1880.
Chicago—E. V. PERKINS, 22 West Maple Street, Chicago 10, Illinois, SUperior 1823.
Los Angeles—RICHARD P. McKEY, 2024 West Sixth Street, Los Angeles 5, FAirfax 1127.
CIRCULATION—C. R. BARRETT, *circulation manager*.
Copyright 1947 by The Petroleum Engineer Publishing Company
Articles in The Petroleum Engineer are indexed by Industrial Arts Index
A. B. C. SUBSCRIPTION: 1 year, $2 — 2 years, $3 A. B. P.

two complete channel-type

CARBON BLACK PLANTS

Plus

★ ONE READY-TO-COMPLETE CARBON BLACK PLANT
★ FOUR DESULPHURIZATION (TREATER) PLANTS

offered 6 ways

FOR SALE OR LEASE FOR "ON-SITE" USE

- as a whole, for operation at present site.
- as a whole, less incomplete carbon black plant No. 3, for operation at present site.
- any appropriate combination of treater plants, burner units and buildings and equipment for operation at present site.

OR FOR SALE FOR "OFF-SITE" USE

- *as a whole, for dismantling and removal.
- incomplete carbon black plant No. 3 only, for dismantling and removal.
- any appropriate combination of treater plants, burner units, buildings and equipment for dismantling and removal.

*If the entire plancor, except dwellings, is sold for dismantling and removal, dwellings will be offered for disposal at a subsequent date.

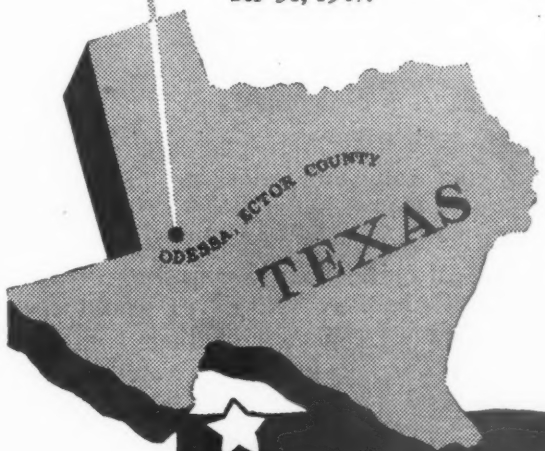
War Assets Administration invites proposals for the purchase or lease of Plancor 2279, channel-type carbon black plants now being operated by United Carbon Company at Odessa, Ector County, Texas.

DESIGNED CAPACITY: Approximately 50,000,000 pounds of carbon black per year.

BUILDINGS AND FACILITIES: 4 Gas Desulphurization (Treater) Plants. Designed capacity 40 million, 40 million, 15 million, 10 million cubic feet of gas per day. Gas Supply Lines. 2 complete Carbon Black Plants. No. 1, one Burner Unit, consisting of 44 Burner Houses, 12′ x 144′ x 9′ and three Burner Units each consisting of 44 Burner Houses, 12′ x 148′ x 9′. Processing, storage and miscellaneous accessory buildings and equipment. No. 2, four Burner Units, each consisting of 60 Burner Houses, 12′ x 148′ x 9′ and necessary accessory buildings and equipment. One incomplete, partially erected Carbon Black Plant No. 3, most of material for 2 Burner Units, each consisting of 60 Burner Houses, 12′ x 148′ x 9′. Most material for processing, storage and accessory buildings and equipment. Dwellings, 4 at each Treater Plant Site and 72 at Odessa, Texas.

LAND: Approximately 425-3/4 acres.

DELIVERY STATUS: Currently this facility is being operated under an interim lease that runs through December 31, 1947.



GAS SUPPLIES: Gas for the production of channel black is now being supplied under contracts held by United Carbon Company with Cities Service Oil Company, Phillips Petroleum Company, and Odessa Natural Gasoline Company. These contracts are not transferrable with the plancor.

The Texas Railroad Commission issues permits for burning natural gas in carbon black plants on an annual basis.

A prospective lessee or purchaser for operation of all or part of the plancor at its present location should make his own arrangements to obtain necessary gas supplies.

SEALED BIDS: Your sealed proposals on Standard Bid Forms will be received by War Assets Administration, Office of Real Property Disposal, North American Plant "B", Grand Prairie, Texas; mail address, P. O. Box 6030, Dallas 2, Texas, until 2:00 P.M., C.S.T., July 16, 1947, at which time all proposals will be publicly opened and read.

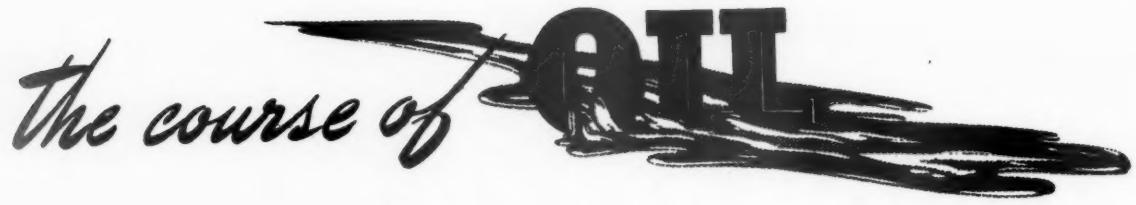
Credit terms may be arranged.

WAR ASSETS ADMINISTRATION
OFFICE OF REAL PROPERTY DISPOSAL

GOVERNMENT WAA SURPLUS

NORTH AMERICAN PLANT "B", GRAND PRAIRIE, TEXAS • P. O. BOX 6030 • DALLAS 2, TEXAS

1199-T



TREATY AND INTERNATIONAL LAW

Recent hearings before the Senate Foreign Relations Committee on the Anglo-American Oil Treaty indicate that many divergent views on the treaty still prevail in the industry. Most of the testimony opposing the treaty seems to arise from a fear of eventual federal control of the oil industry. Strong testimony has been offered in defense of the treaty, much stronger in some respects than the testimony opposing it. Plainly, confusion exists regarding the language of the treaty itself, judging by the many interpretations placed upon it.

The fact that this confusion over the treaty exists even after it has been revised and clarifying clauses added, has created doubt in the minds of many in the industry regarding the real purposes of the treaty.

Charles Fahy, who is legal advisor to the Secretary of State, quoted from a Supreme Court decision to illustrate his point that the treaty provides only that the signatory nations would direct their efforts toward accomplishing their objectives of the treaty, "A treaty is in its nature a contract between two nations, not a legislative act. It does not generally effect, of itself, the object to be accomplished, especially so far as its operation is intraterritorial; but is carried to execution by the sovereign power of the respective parties to the instrument.

"In the United States a different principle is established. Our constitution declares a treaty to be the law of the land. It is, consequently, to be regarded in courts of justice as equivalent to an act of the legislature, whenever it operates of itself without the aid of any legislative provision. But when the terms of the stipulation import a contract, when either of the parties engages to perform a particular act, the treaty addresses itself to the political, not the judicial department; and the legislative must execute the contract before it can become a rule for the Court."

Fahy also said that under this agreement Congress would not have any regulatory power that it does not possess. Senator Connally pointed out, however, that while it may be true that the treaty does not confer any additional powers on the Federal Government, still the Government might be obliged to exercise some of the latent powers that it now possesses but does not exercise.

Senator Vandenberg, who is Chairman of the Senate Foreign Relations Committee, himself has expressed doubt regarding the clarity of the treaty as written. Even Senator George, a recognized authority on international law, inferred from the nature of his questioning of witnesses at the hearings, that the Federal Government may be bound to control the domestic industry in some way.

On the face of it, if the purpose of the treaty is to facilitate international oil trade, domestic oil trade in the countries concerned may eventually be affected. In this connection, Ralph Davies, a strong proponent of the treaty, has stated that the expression "International trade," which appears several times in the Preamble, "underscores the fact that the Agreement is concerned with oil in international trade, and not with oil produced and consumed domestically. This is an important point, which is dealt with more specifically in the body of the treaty."

In further defense of the treaty he said that "With respect to the contention that the Agreement makes possible a world petroleum cartel, it is most difficult to believe that any such view is advanced in good faith. Everything relating to the Agreement, the circumstances out of which it originated, the purposes which it sets forth, the method of its administration, are precisely the reverse. What we are here discussing is an instrument which proclaims that there is an abundance of petroleum, agrees that ample supplies of it should be accessible to all on a competitive and nondiscriminatory basis and pledges the two Governments to exert their efforts toward the removal of existing restrictions on the free flow of petroleum in international trade."

There is much to be said for the treaty as providing a forum for the oil industries of different countries getting together and a means of discussing common problems and smoothing out difficulties. As has been expressed by Eugene Holman, President of the Standard Oil Company (N. J.), it would also assist private companies in their dealings with foreign governments, and thus promote private business under the competitive system.

To assess the value and the implications of the treaty, it would seem that a knowledge of international law is involved. If that is so, perhaps, further clarification on this (international law) aspect of the treaty by an authority is necessary.

—K.C.S.

ENGINEERING SERVICE

FREE!

(Patents 2,220,237 and 2,258,052)
Spiral Centralizer

Weatherford Engineers, schooled in the latest cementing techniques, stand ready every minute of the day and night to rush to your job—wherever it may be. These engineers are thoroughly familiar with every possible cementing problem concerning (1) Preparation for the run, (2) Installation of Spiral Centralizers and Reversible Scratchers, and (3) Running-in Operations.

Weatherford Engineering Service costs you nothing and it often saves hours of delay. When you get ready for your cementing job, just call COLLECT:

LD-1 WEATHERFORD, TEXAS

Weatherford Spiral Centralizers and Reversible Scratchers, used according to Weatherford Methods, assure successful cementing jobs and the saving of time and money. Thousands of Weatherford engineered completions stand as positive proof of this statement.

Call a Weatherford Engineer to your next cementing job.... Telephone collect: LD-1, Weatherford, Texas.

(Patent No. 2,374,317)
Reversible Scratcher

WEATHERFORD

Spring Company

Manufacturers of Oil Well Specialties

WEATHERFORD, TEXAS
Telephones: 257 and LD 1

WEST COAST PLANT
3316 JEWETT AVENUE
BAKERSFIELD, CALIF.
Telephone 4-4334

EXPORT OFFICE
617 SOUTH OLIVE ST.
LOS ANGELES, CALIF.
Telephone VAndyke 8409

SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—More and more the signs point to some sort of voluntary pooling program to stretch supplies of crude oil and products, utilize all refining capacity, and share transportation and distribution facilities in an all-out effort to meet this year's record-breaking demands.

Industry groups are still battling for more tubular goods and pipe, more refinery materials and steel for tank cars. Admittedly, though, they won't get enough to help much in expanding productive capacity this year. So, it is another case of making the most with what is available—as the industry did so often during the war.

Some industry leaders insist that there are enough products in sight to meet all the requirements of the military, governmental agencies and civilians—but it will require industry-wide coordination to keep all refineries operating and supplies properly distributed. Such concerted action, however, would require antitrust law clearance by the Department of Justice. After the Madison Oil Case, oil company lawyers will insist on that.

Legislation is still on the books authorizing such a pooling and sharing program, as was done repeatedly during the war. But the military would have to certify that it was "necessary to the war effort" (the war is still on, officially). The DJ would go along—but reluctantly, and would surely urge some sort of governmental supervision of such a program.

Ever since President Truman earlier this month, in his Kansas City speech, told the nation that we face a shortage of petroleum products and declared that spot shortages of fuel oil have already appeared, there has been increasing evidence of the Truman Administration's concern over the petroleum situation.

Top-level officials have been conferring on what can and should be done. Military leaders have grown tougher in their insistence that the Army and Navy must be supplied with all the products needed to meet current requirements; also, some provision should be made for building back inventories against any emergency. There has been talk of requisitioning and of rationing civilians if that is necessary to provide oil for the military.

It is a good bet, however, that the Truman Administraton would favor giving the industry a chance, by concerted effort, to meet demands before resorting to governmental rationing, if ever.

Such a program may take the form of an NRA in reverse (in 1933, the effort was to bring supply into balance with decreased demand). It might include provision for wider sharing of crude supplies, exchanges of products, joint use of transportation facilities and proration of supplies at the distributors' level.

A rough road would lie ahead for such a program. It would be a thankless job, at best. And at the end of the trail might be another Madison antitrust case. (Right now, a grand jury investigation of oil prices on the West Coast is impending; also, antitrust investigations are under way on tank cars, refining patents, unitization plans, and some aspects of marketing.)

On the other hand, few in the industry want to return to wartime governmental controls. For example, producers want more tubular goods but they would oppose a return to the allocations system. Indeed, producers are fighting for removal of controls on export of pipe although criticizing the increased volume of tubular goods going to foreign oil operations. They contend that the State Department has used the export control system as an instrument to provide more pipe for operators abroad.

While industry leaders insist that the present tight supply situation is only temporary, due to lack of steel for drilling, refinery expansion, more transportation facilities, etc., it was inevitable that the "oil shortage" talk should be merged with discussion of long-term policies. Fortunately or not, it may hasten action to develop a national oil policy.

During hearings before the Senate Foreign Relations Committee on the Anglo-American Oil Agreement, Ralph K. Davies (Ex-PAW), appearing for Interior Department, declared: "We do not *face* an oil shortage. We are *in the midst of one*—now." A press release was issued on behalf of Davies, quoting him as saying:

"I had some experience with rationing of gasoline and heating oil and I can testify first hand that people didn't like it. If it comes again—as well it may—I don't believe that the public will feel kindly toward any who have taken it upon themselves to kill a treaty that could have given assurance that we should continue to have access to supplemental supplies from abroad. I doubt that boasts of past accomplishments will pacify, if that time comes, for boasts will not heat homes or run automobiles."

Proponents of the oil treaty made a poor case for its necessity now. In fact, they supplied the treaty's foes with ammunition. So much so that Senator Vandenberg, chairman, indicated additional reservations would be advisable.

Strangely enough, though, the oil treaty now has some hope of ratification whereas a few weeks back it was generally regarded as dead, almost beyond resurrection. President Truman will be inclined to press it because he dare not leave a stone unturned that might add to our oil supply. For the same reason, Republicans in the Senate may go along with Truman after tacking on some reservations to answer complaints against the text, as it now stands. (Consuming states are not worried a bit over the treaty's alleged threat of increased oil imports.)

Meanwhile, some fuel oil from the Middle East is due to arrive in this country soon, probably during July.

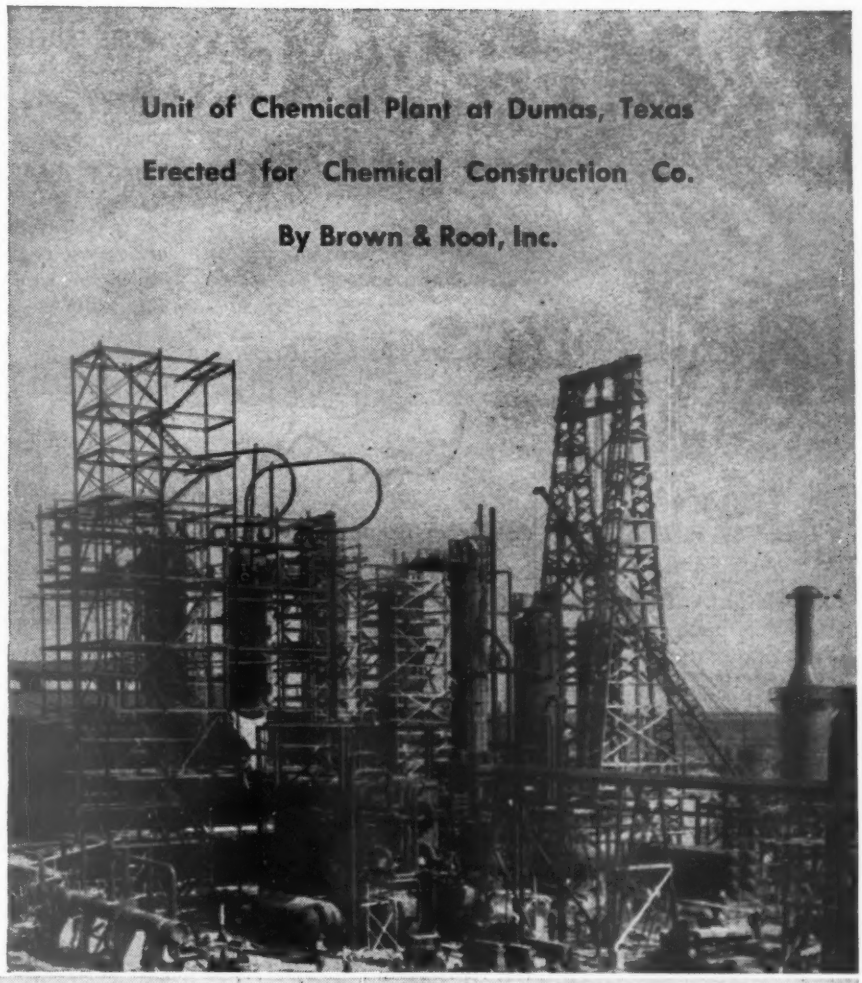
The Navy has arranged to obtain an additional 500,000 barrels per month of Navy Special Fuel Oil, under present contracts, from American owned refineries at Ras Tanura and Bahrein Island in the Persian Gulf. The Navy will send its own tankers to pick up the fuel oil and bring it back for use of the Atlantic Fleet. Some of this oil will be stored at Norfolk and other storage points on the East Coast. Thus, predictions are borne out that Middle East fuel oil would reach the United Staes this year.

● **KRUG NAMES INDUSTRY UNIT.** Secretary Krug announced this month the appointment of 15 leaders of the oil and gas industry to the military petroleum advisory committee. The committee will advise the army-navy petroleum board and the interior department's oil and gas division on petroleum matters affecting national defense or security. Committee members are:

Paul G. Benedum, Hiawatha Oil and Gas, Pittsburgh; T. E. Buchanan, The Texas Company, New York; Stewart P. Coleman, Standard of New Jersey; E. L. DeGolyer of DeGolyer and MacNaughton, Dallas; J. Terry Duce, Arabian-American Oil Company, Washington; R. G. Follis, Standard of California, San Francisco; B. I. Graves, Tide Water Associated Oil, New York; George A. Wilson, Interstate Natural Gas, Baton Rouge; D. B. Hodges, Shell, New York; B. L. Majewski, Deep Rock, Chicago; R. L. Minckler, General Petroleum, Los Angeles; J. Howard Marshall, Ashland Oil and Refining, Ashland, Kentucky; J. R. Parten, Woodley Petroleum, Houston; E. E. Pyles, Los Angeles; Bruce K. Brown, Standard of Indiana, Chicago. Charles L. Harding, Socony-Vacuum, was named legal adviser.

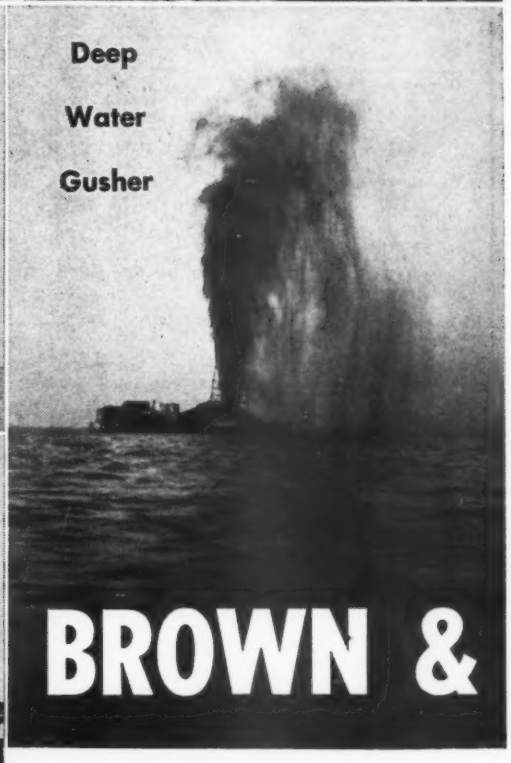
Process Plant Service *PLUS*

YES, we'll give you complete service on your process plant, from design through engineering, fabrication and erection. And we'll take care of your other needs, such as roads, bridges, pipe lines, power lines, power plants or deep water well locations, like the Brown & Root, Inc. jobs illustrated here.



Unit of Chemical Plant at Dumas, Texas
Erected for Chemical Construction Co.
By Brown & Root, Inc.

One Mile Pier to Location
In Gulf by Brown & Root, Inc.



Deep
Water
Gusher

Oil Well Foundation in Gulf of Mexico

BROWN & ROOT, Inc.

P. O. Box 2634, Houston 1, Texas

national petroleum situation

By H. J. STRUTH,* *Petroleum Economist*

OKLAHOMA DRILLING BOOM. Well completions in Oklahoma have shown an increase of 67 per cent over last year. Completions since January 1 were 1601, against 958 last year. Wildcats are 90 per cent above last year, with 330 drilled this year, against 174 last year. Claude Barrow, Oil Editor of the Daily Oklahoman, says much drilling is being done by a new crop of investors, principally war contractors.

*Editor *The Petroleum Data Book.*

MORE DRILLING NEEDED. Outside of Oklahoma the number of wells drilled for oil and gas is not in keeping with economic requirements. Well completions since January 1, exclusive of service wells, totaled 11,298, against a minimum cumulative quota of about 12,835.

HEAVY GASOLINE DEMAND. May demand for gasoline rose to a daily average of 2,350,000 bbl, against 2,252,000 bbl a year ago. Cumulative demand is about 4 per cent above last year; is expected to reach new all-time peaks during the next three months. Stocks were reduced nearly 6,200,000 bbl in May, to a level of 39 days' supply, against 41 days last year. Production is up 5 per cent over last year; stocks are off 2 per cent from last year.

INCREASED CRUDE SUPPLY. Crude oil supply in May averaged 5,258,000 bbl daily, against 5,143,000 bbl last year. Cumulative supply was 5 per cent greater while demand was up 4 per cent. Domestic crude production has been maintained in equilibrium with requirements since January 1, but stocks have increased 8 per cent over last year, due to increased imports. May crude supply exceeded demand by about 64,000 bbl daily.

REFINING BELOW QUOTA. Based upon present and prospective demand for products, refinery crude runs since January 1 should have averaged about 4,900,000 bbl daily. Actual runs for the five months have been 4,801,000 bbl daily. Refining schedules are about 2 per cent below normal requirements. Still runs have increased 3 per cent over last year, but demand for motor fuel is up 4 per cent, while fuel oil demand has increased 12 per cent.

Comparative Statistics, May, 1947

*All figures are computed on a Bureau of Mines' Basis**

	May 1947(p)	April 1947(p)	May 1946	This year to date	Last year to date	Per cent change
Wells drilling	3,790	3,750	3,570	3,790	3,570	+ 6
Total wells drilled§	2,449	2,370	2,489	11,977	11,340	+ 6
Development wells	2,071	2,038	2,111	10,163	9,704	+ 5
Oil	1,323	1,257	1,290	6,339	6,029	+ 5
Gas	248	213	215	1,221	1,028	+19
Dry§	500	567	606	2,603	2,647	— 2
Per cent dry	24.1	27.8	28.7	25.6	27.3	— 1.7
Wildcat wells	378	332	378	1,814	1,636	+11
Oil	61	64	56	271	249	+ 9
Gas	21	11	10	67	45	+49
Dry	296	257	311	1,476	1,342	+10
Per cent dry	78.3	77.4	82.4	81.4	82.0	— 0.6
Crude supply*	163,000	156,400	155,842	776,523	736,352	+ 5
Daily average	5,258	5,213	5,027	5,143	4,877	
Drude demand‡	161,000	147,400	156,350	760,719	733,106	+ 4
Daily average	5,194	4,913	5,044	5,038	4,855	
Crude stocks	244,500	242,500	226,505	244,500	226,505	+ 8
Days supply	47	49	45	47	45	
Natural gasoline production	10,924	10,200	9,379	52,512	46,668	+13
Daily average	352	340	303	348	309	
Motor fuel production	66,670	62,170	65,191	321,930	305,868	+ 5
Daily average	2,151	2,072	2,103	2,132	2,026	
Gasoline yield, per cent	39.0	39.2	38.8	39.4	38.1	+ 1.3
Motor fuel demand‡	72,850	66,420	69,812	319,883	306,745	+ 4
Daily average	2,350	2,214	2,252	2,118	2,031	
Motor fuel stocks^	91,370	97,550	92,805	91,370	92,805	— 2
Days supply	39	44	41	39	41	
Fuel oil production	61,390	57,850	61,164	299,350	304,816	— 2
Daily average	1,980	1,928	1,973	1,982	2,019	
Fuel oil demand‡	63,000	66,220	62,322	371,054	332,702	+12
Daily average	2,032	2,207	2,010	2,457	2,203	
Fuel oil stocks	76,000	¶69,500	72,817	76,000	72,817	+ .4
Days supply	37	31	36	37	36	
Refinery still runs	152,180	140,760	148,621	724,910	703,355	+ 3
Daily average	4,909	4,692	4,794	4,801	4,660	
All refined stocks	241,000	240,100	244,511	241,000	244,511	— 1
Days supply	44	44	47	44	47	

Economic Position of U. S. Petroleum Industry

Five Months Ending May 31, 1947

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	12,835	11,298	88
Production (daily crude output)	4,865	4,873	100
Refining (daily still runs)	4,900	4,801	98
Stocks (crude and refined)	500,000	485,500	97
Price of crude (per bbl)	$1.88**	$1.92	102

Current Crude Oil Prices

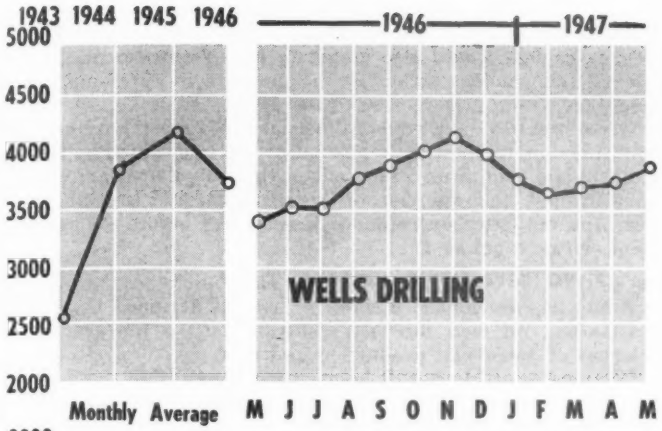
U. S. average	$1.92	Louisiana	$1.92	**Basic crude prices**	
Texas	1.91	Arkansas	1.73	Oklahoma-Kansas (36 gr.)	$1.87
California	1.66	New Mexico	1.70	Texas Gulf Coast (36 gr.)	2.07
Oklahoma	1.93	Mississippi	1.72	East Texas	1.95
Kansas	1.92	Illinois	2.06	West Texas (36 gr.)	1.74
		Other states	2.54	California Signal Hill (26 gr.)	1.71
				Pennsylvania, Bradford	4.05

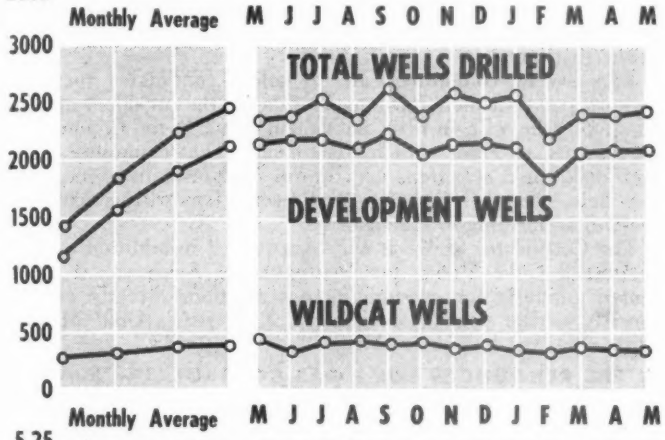
Drilling and Production Statistics by States

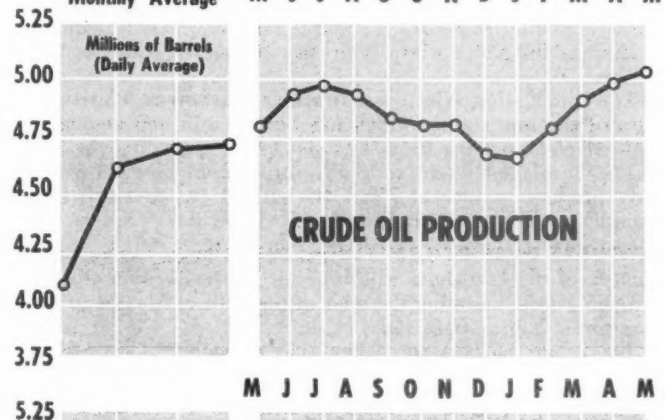
	May 1947(p)	April 1947(p)	May 1946	This year to date	Last year to date	Per cent change
Total wells drilled§	2,449	2,370	2,489	11,977	11,340	+ 6
Texas	704	710	719	3,403	3,277	+ 4
California	163	190	152	803	751	+ 7
Oklahoma	303	285	195	1,601	958	+67
Kansas	207	188	179	999	804	+24
Louisiana	119	102	128	510	539	— 5
Arkansas	28	20	15	106	72	+47
New Mexico	34	42	24	209	153	+37
Mississippi	49	30	19	166	98	+69
Illinois	134	144	175	736	863	—15
Other states	708	659	883	3,444	3,825	—10
Wildcats drilled	378	332	378	1,814	1,636	+11
Texas	138	134	169	667	633	+ 5
California	30	36	14	142	94	+51
Oklahoma	50	59	26	330	174	+90
Kansas	32	23	23	133	112	+19
Louisiana	25	18	17	100	99	+ 1
Arkansas	8	4	5	23	13	+77
New Mexico	1	3	5	17	26	—35
Mississippi	7	3	2	32	26	+23
Illinois	31	16	44	128	183	—30
Other states	56	36	73	242	276	—12
Crude oil production	5,026	4,945	4,785	4,873	4,641	+ 5
Texas	2,229	2,179	2,117	2,117	2,022	+ 5
California	916	907	866	902	854	+ 6
Oklahoma	388	381	372	377	375	+ 1
Kansas	288	283	264	278	256	+ 9
Louisiana	422	416	384	419	377	+11
Arkansas	81	79	78	80	77	+ 4
New Mexico	106	102	101	104	99	+ 5
Mississippi	90	88	62	87	57	+53
Illinois	184	182	212	187	209	—11
Other states	322	328	329	322	315	+ 2

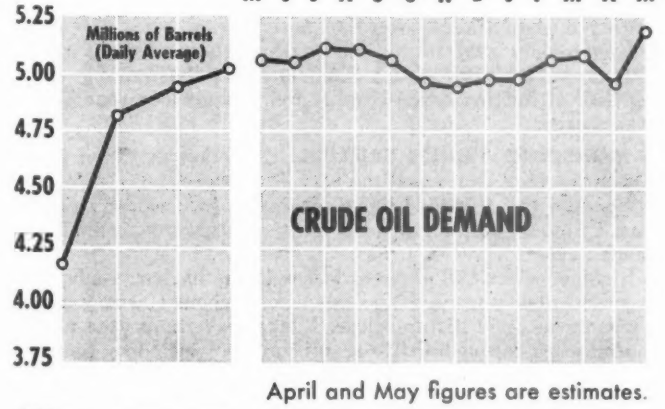
*Unless otherwise stated all figures represent thousands of barrels. ***Does not include input wells. (p) Preliminary. *Includes domestic production and imports.
‡Total demand, including exports. **Price 1926 (Index 100). ^Includes finished and natural gasoline. §Includes service wells. ¶Revised.

Preliminary estimates based upon data furnished by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources

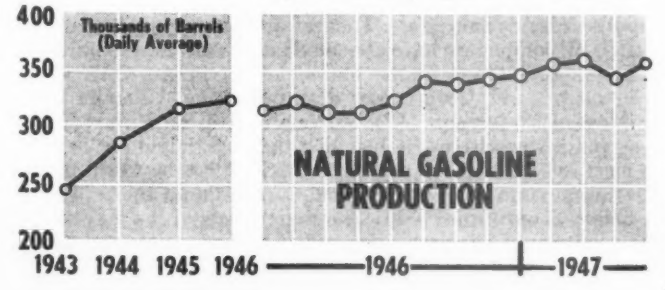


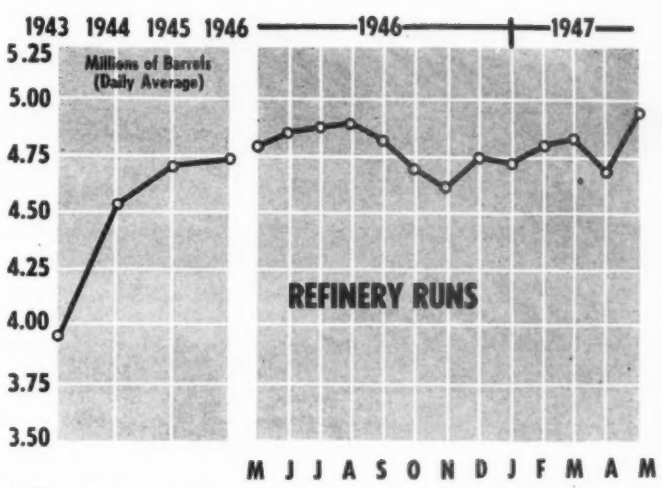


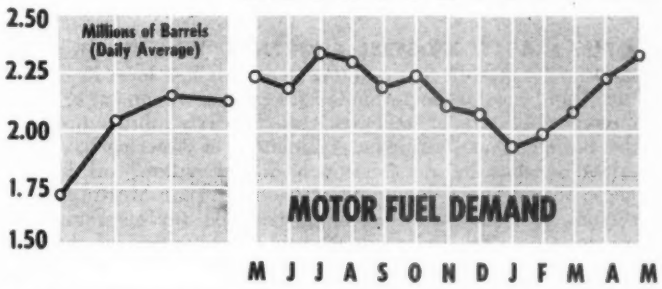


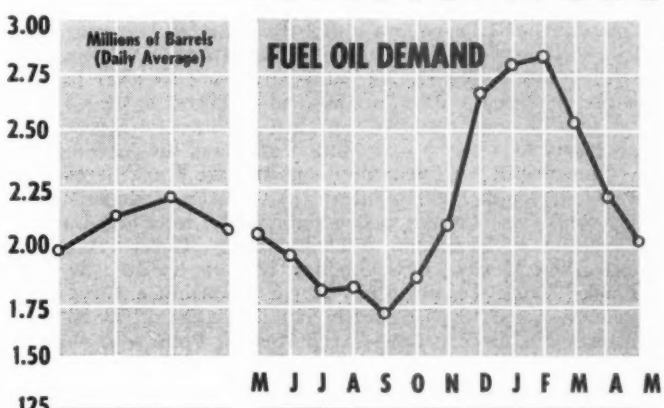


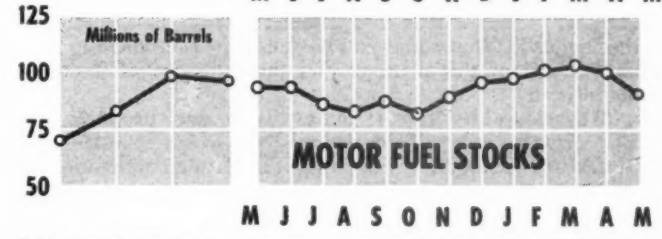
April and May figures are estimates.

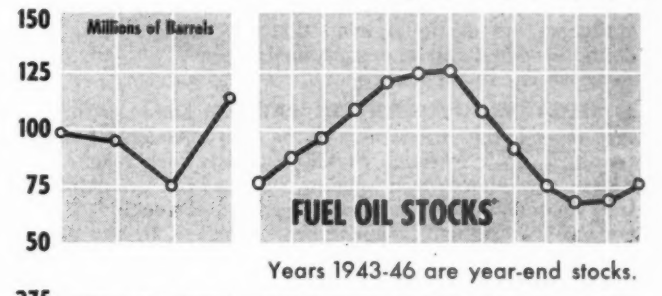




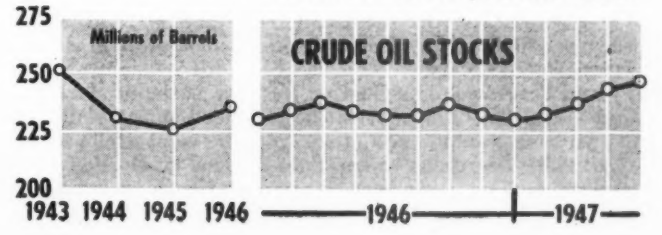




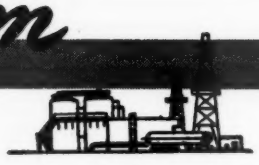




Years 1943-46 are year-end stocks.



highlights in oildom



● **IPAA ACTS ON STEEL SHORTAGE.** With the domestic demand for petroleum products at the highest level in history, the oil industry of the nation is having its development seriously hampered by lack of steel goods, particularly tubular products, the Independent Petroleum Association of America has determined through its membership in all the nation's oil development areas. The association, at the Mid-Year Meeting of Directors in Jackson, Mississippi, resolved to investigate this shortage of steel and characterized the situation as the most pressing problem of the domestic industry.

Furthering this action the association appointed a special committee of 17 members with J. Ed Warren, Midland, Texas, as chairman to make a thorough investigation of the entire steel situation. The results of this study will form the basis for action designed to alleviate the steel shortages in the oil industry in order that the producers can continue the development necessary to meet the increasing demands of the consumer.

Named with Warren on the committee are Frank Bernsen and W. G. Warnock, both of Tulsa; J. W. Frazier of Houston; R. J. Lawton, Magnolia, Arkansas; George P. Livermore, Lubbock, Texas; A. E. Herrmann, Amarillo, Texas; Charles Aston, Artesia, New Mexico; F. G. Stodder, Wichita, Kansas; Bryan W. Payne, Tyler, Texas; F. E. Harper, Oklahoma City; O. G. Leichliter, and James S. Loftin, both of Dallas; J. W. Hancock, Huntington Beach, California; Russell Patterson, Wewoka, Oklahoma, and J. P. Coleman, Wichita Falls, Texas.

Members of this committee have been advised by B. A. Hardey, president of IPAA, of latest data on the situation with the suggestion that additional local data be assembled to permit an analysis of the shortage and the influence of it on local operations.

A considerable share of the available steel products of the United States is now being shipped to foreign countries and a preference is seemingly being given foreign deliveries over shipments to the domestic users who urgently need the materials for their exploration and development work, according to IPAA. As pointed out by President Hardey, the domestic oil producers are of the opinion that the users of this nation should have first call on needed steel products with any surplus being subject to export.

● **SEEK NEW AGREEMENT ON IRAQ OIL.** The basis for a new agreement by major partners of the Iraq Petroleum Company, acceptable to the French participants, has been reached after a series of conferences in London, Standard Oil Company (New Jersey) announces. The new agreement, if concluded, would replace the original group agreement signed by the partners in 1928 and would thus eliminate the circumstances under which the French partners recently instituted legal action to prevent Standard Oil Company (New Jersey) and Socony-Vacuum Oil Company from acquiring an interest in Arabian American Oil Company.

If an agreement is signed on the new basis, production of Iraq Petroleum Company will be expanded substantially, and the partners would obtain crude from the company in accordance with their needs rather than in fixed proportion to the total production as has been the case previously, it is asserted. The further increase in production would not actually take place until about 1952, the earliest time by which the necessary additional pipe-line capacity could be completed. The new agreement would also eliminate the previous restrictions against independent action by the partners in developing oil resources within a large area of the Middle East.

According to Jersey Standard officials, who recently returned from London, the new basis has not yet been accepted by C. S. Gulbenkian, who owns 5 per cent of the Iraq Petroleum Company through his ownership of Participations and Investments, Ltd., and the latter's acceptance is necessary before the agreement can be concluded.

● **API TO GIVE MERIT AWARDS.** The American Petroleum Institute has announced a series of awards designed to honor outstanding oil men for their contributions to the arts and sciences of petroleum production and use.

Certificates of Merit will be awarded annually to those who have rendered outstanding and extraordinary services as an officer or member of a division, committee, or other organized unit of the Institute.

Five award committees are to select candidates for the awards, transmit their recommendations to the president of the Institute, who will, in turn, pass them along to the Committee on Awards, together with his comments. That committee will then make final selections and inform the president of its findings before October 1, each year. Presentations will be made at the annual meeting of the Institute.

The Certificates of Merit will be awarded in addition to the Institute's Gold Medal for Distinguished Achievement presented annually for outstanding contributions directly or indirectly to the petroleum industry. Last year's Gold Medal winner was the late Henry Ford.

● **FPC RENOUNCES SOME GAS CONTROL.** The Federal Power Commission has notified the natural gas industry that it plans to put into effect a regulation exempting producers, gatherers, and processors of natural gas from FPC jurisdiction if the gas did not go into interstate commerce while in their hands.

The commission said it was drafting this new regulation "in view of the uncertainty which has been manifested among the state officials and the industries concerned regarding the commission's alleged intent to assert jurisdiction over those who only produce, gather and process natural gas and sell it on completion of such operations."

● **CURBS GULF DYNAMITING.** Commissioner Luther Montgomery of the Louisiana wildlife and fisheries commission has ordered that dynamiting the floor of the Gulf of Mexico in seismographic explorations must cease.

The action, he said, was taken after a number of Gulf fishermen complained the dynamite shots make craters and hills on the floor of the waters and that their nets and trawls are being destroyed when dragged over the uneven floors.

Montgomery said future seismograph shots must be made with explosives suspended a few feet below the water level in the Gulf of Mexico, Mississippi sound, Chandeleur sound, and Lake Borgne.

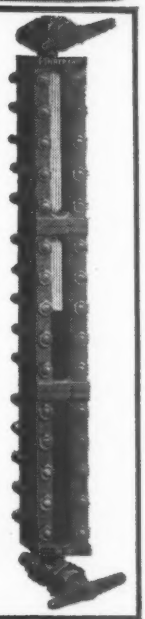
● **CONSIDERS TUNNEL DRILLING.** Objection to island drilling by the U. S. Navy and the City of Long Beach, California, has caused the Richfield Oil Corporation to consider drilling from a tunnel to tap oil deposits under the east side of the Long Beach harbor.

Richfield owns 278 acres of leases in the harbor. Under the proposed plan tunnels would be sunk to about 600 ft, extending as far as 2000 ft from shore. A large cavernous area would be excavated for each drill site, all to be connected by tunnels.

● **AUSTRALIAN OIL SEARCH INTENSIVE.** The search for oil in Australia is the most intensive in the history of the dominion, reports from Sydney state. Federal and state governments, as well as oil companies, have allocated large sums for the purpose.

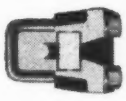
Increased interest in the finding of oil in Australia is attributed to: (1) Government desire to make Australia independent of oil imports; (2) wartime inroads on United States reserves, giving rise to the fear that the U. S. might not be able to meet export demands; (3) recognition that the world industrial trend is away from solid fuel toward liquid fuel; (4) uncertainty about future political developments of the oil-producing countries of the Near East, and (5) prewar oil search plans of oil companies can now be put into operation.

PENBERTHY
"REFLEX"
DROP FORGED STEEL LIQUID LEVEL GAGES



Liquid always shows black—empty space shows white. Preferred where the liquid level must be easily and positively visible, and when liquids are under high pressure or at high temperature. Made of alloy temperature resisting steel and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

The "Reflex" is one of the complete line of Penberthy Gages that meet every liquid level gage requirement.



PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
"REFLEX"
WATER GAGE SET

For oil field, locomotive type and marine boilers. Water shows black—steam shows white; the water level is unmistakable. U-Bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler. Conforms with A.S.M.E., Federal and State requirements when used for pressures specified by their respective codes.

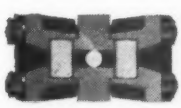
This is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
"TRANSPARENT"
DROP FORGED STEEL LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures and/or temperatures. Construction exceptionally sturdy. Made of alloy temperature resisting steel, and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

The "Transparent" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.



PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
SUMP PUMPS

Used wherever seepage water accumulates, the Penberthy Automatic Electric Sump Pump and the Penberthy Automatic Drainer (water or steam operated) have demonstrated their superiority in this service. Simple and rugged design—copper and bronze construction throughout.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
AUTOMATIC INJECTORS

The accepted method for assuring an uninterrupted supply of feed water to oil field boilers. Penberthy Automatic Injectors will supply feed water to boilers at minimum cost, are quickly and easily installed, reliable under most severe operating conditions, require little attention and no careful handling. Highest quality design and rugged construction.

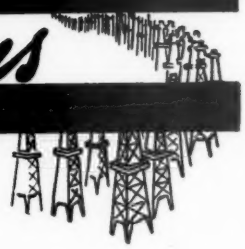
PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
EJECTORS

Use the power of steam, air or water under pressure to lift liquids. Being simple jet pumps they have no moving parts and require no lubrication. A variety of models to meet different conditions. Also used as water heaters.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

current oil field operations



Exploration wells that have found production.

● **OKLAHOMA.** Carter 1 J. J. Harrison, C SW SW 31-5n-3w, East Lindsay, McClain. Estimated 100 MCF gas and drillstem test showed 450 ft of oil, from Deese at 7614-65.

Mid-Continent 8 Terry, SE SE SW, 30-12-7, Garden Grove pool, Okfuskee. Flowed 350 B from Lower Wewoka at 2568-88 ft.

Sohio 1 Howard, discovery well of Eola field, 17-1n-2w, Garvin. Flowing allowable of 400 B oil per day from Bromide at 10064-234 ft.

Davon 1 Tautfast, NE SW NE, 32-24n-1e. Estimate production at 350-400 B per day from Bartlesville at 4352-526 ft.

James N. Crofton 1 Loretta, SE SE SE, 7-3n-1w, Garvin. Flowed 15 B oil per hr for 6 hr from 5170-210 ft and then died. Cleaning for revival of flow.

British-American et al 1 Van Ostrand, C SE SW, 2-1n-2w, Oklahoma. Flowed 217 B oil in 21 hr from Hunton at 6142-65 ft.

Carter 1 Bohanan, NW NE SW, 14-2-2n, Garvin. Flowing from Gibson sand at 6437-52 ft.

Derby 1 Weigel, NE NE SE, 2-21n-2w, Noble. Test showed gas and oil from 5127-39 ft in second Wilcox. Second pay zone.

Texola Drilling et al 1 Canard, NW NW NW, 33-10n-10e, Okfuskee. Drillstem test 150 ft oil at 3886-915 ft in Hunton.

● **KANSAS.** Alva Billings and Assoc. 3 Dave B. Dumler, S½ NE, 24-14-14, Russell. Large volume of gas and oil from new pay at 1995 ft.

Solar 1 Tammen, SWC, 24-19-16w, Rush. Flowed 100 B oil per day and 500 MVF gas from Arbuckle at 3660-700 ft.

Sohio and Kiowa Drlg. 1 Horejsi, NW NW NW, 12-16-11w, Barton. Swabbed ½ B an hr at 3358 ft in Arbuckle. Swabbed 1 B of oil an hr at 3039-46 ft from Lansing lime.

Great Lakes Carbon et al 1 Dirks, SW SW SE, 16-18-18w, Rush. Drillstem test 1210 ft of fluid, 65 per cent of oil at 3836-65 ft Arbuckle.

Derby Drlg. 1 Behnke, NE NE NE, 15-19-10w, Brandenstein pool, Rice. 545 B oil per day from new pay at 3199 ft.

Alladin 1 Dugan, NW NW SE, 7-28s-1w, Sedgwick. Drillstem test showed 2200 ft oil at 3660-03 ft in Simpson and 150 ft oil and 3690 MCF gas at 3338-83 ft in Mississippi.

● **NEW MEXICO.** Barnsdall 1 Elliot-Federal, 20-21-37e, Lea. 90 min drillstem test showed 180 ft oil at 6630-6685 ft.

● **INDIANA.** Farm Bureau old reopened well in SW SE SW, 30-5s-13w, Posey. IP 280 B of oil per day from Palestine sand at 1960-67 ft.

● **ILLINOIS.** W. O. Allen 1 Brimble-Combe, SW SE, 28-5s-10e, White. Makes 580 B from Tar Springs sand at 2360-2376 ft.

Joe Reznik 1 Herman F. Grant, SW SW SE, 13-7s-9e, White. Drillstem test recovered gas in 35 min, 2000 ft clean oil, 60 ft oil cut mud, no water from Waltersburg at 2290-2300 ft.

Central Pipe Line and Hayes Drlg. 1 Harrell-Hunley NW NE NW, 35-4n-9e, Richland. Drillstem test recovered gas in 2 min and oil flow in 8 min from McClosky lime at 2926-38 ft.

● **LOUISIANA.** Atlantic 1 New Port Industries, 11-5s-12w, Juanita prospect, Beauregard. Potential flowed 113 B 40° from 7272-78 ft, Cocksfield sand. IP 283 B per day.

R. O. Roy and British American 1 Trixie Wimberly, 2-13n-10w, Red River. Swabbed 12 B fluid, of which 15 per cent was oil, from 2677-79 ft.

California 9 E. P. Brady, Lse. 4, 19-16s-24e, Alliance pool, Plaquemines. Flowing potential of 89 B 38.1° in 24 hr from 8252-9257 ft.

Sohio and Union Sulphur 1 Harson, 5-10s-3w, Acadia. Flowed 18 B condensate and 1750 MCF gas from 10,840 ft.

Humble 13-B Petit Anse, 23-13s-5e, Avery Island pool, Iberia. Flowed IP 324 B 35° oil and 262 MCF gas from new sand at 10,310-360 ft.

R. T. Sellars et al 1 Monzingo River Lbr., 23-22n-1w, Union. Flowed 12 B oil per hr from 2136-52 ft.

Marine 1 Ayer Timber, SW SW, 19-15n-10e, Madison. Flowed 36 B condensate and 1550 MCF gas per day from 5630-90 ft.

Lion 1 Ozley, Bienville. 40 million cu ft of gas a day from around 7700 ft.

● **TEXAS.** M. E. Davis (Benedum and Trees) 1 Johnson, Quirk Sur., San Augustine. Flowed 625 B 46° oil from Pettit at 8145-65 ft.

Sun 2 Lutcher-Moore Lumber, James Duson Sur., Orange. Potential of 178.53 B 34.1° oil from 7589-601 ft.

Cities Service et al 1-B Owen, 6-GG-H&OB, Crockett. Flowed 8½ B 41° oil per hr and 4100 MCF gas daily from 5645-50 ft in Wolfcamp.

Tide Water 1 J. D. Hudgins G. H. & H. Sur., Wharton. Drill stem test recovered gas with dark oil at 6715-20 ft.

Stanolind 1 Marcus D. Huebner, Porter Bertrand Sur., Matagorda. Flowed 134.4 B 36° oil in 20 hr from 9236-38 ft for new area.

Holt 1 Gray, Nall Sur., Marion. Pumped 47 B 47° oil per day from 2730 ft.

Honolulu 1 White and Shelton, 404-G-CCSD&RGNG, Gaines. Swabbing oil around 3000 ft.

Houston 1 Eugene L. Bender Estate, James W. Singleton Sur., Harris. Open flow potential of 22 MMCF gas with 30 B condensate from 7782-8402 ft.

Humble 6 Virginia McCaleb, H&TC Sur., Wilbarger. Flowing potential of 2405 B per day from 6242-345 ft.

Mac Drlg 1 Payne, Vital Flores Sur., San Jacinto. Daily flowing potential of 76 B 36.8° oil from 7682-7708 ft.

Continental 1 Magee, C. A. Wright Surv., Montague. Pumping 159 B 40° oil per day from a new Strawn pool at 6018-38 ft.

J. C. Hunter 1 Josie Shanks, R. Smith Surv., Jones 149 B per day from 2364-97 ft.

Tom F. Hunter 1 J. B. Mathews, Sec. 60, Comanche Indian reserve, Throckmorton. Drillstem test recovered 1100 ft of free oil from lower Caddo at 4506-11 ft.

Humble 1 Yarbrough and Allen, Public School Lands Surv., Ector. Test showed 460 ft of free oil from 8230-8283 ft.

American Republic 1 Kirby Lumber, Sarah Fields Surv., Tyler. Drillstem test flowed 23 stands 42° oil from 9066-80 ft.

Magnolia 1 J. W. Grounds, J. G. Luce Surv., Tyler. Swabbed 36° oil from 8922-8945 in the upper Glen Rose.

Tide Water and Dirks Bros., 1-B Page Estate, J. W. McFarland Surv., Bee. Flowing 139 B 36.8° oil from Mackhank at 7429-7438 ft.

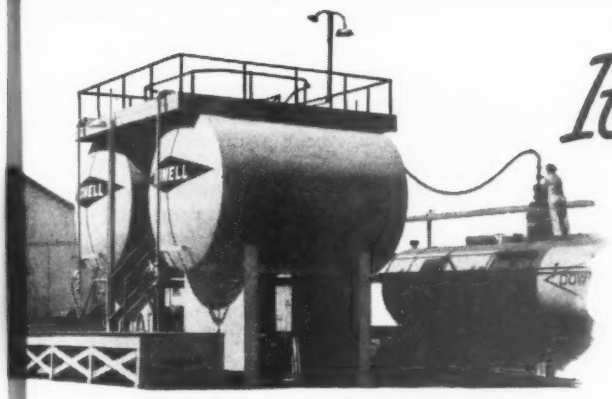
Texas 6 Yturria Land and Livestock, Willacy. Will test show of saturation just above 16,000 ft level.

Ryan Cons. 1 Theresa H. Wagner, Manuel Lopez Surv., Calhoun. Production is from 5980-6006 ft.

● **MICHIGAN.** McClanahan 1 Knoodle, 13-17e-3e, Bay. Flows 100 B per day since completion May 8.

● **RUSSIA.** Soviet geologists announced the discovery of great reserves of oil in the Ural Mountains, 1000 mi east of Moscow. Announcement was made after the completion of exhaustive tests in this new industrial region.

● **BOLIVIA.** YPFB reported new pay in the Camiri field at 1643 ft while deepening a well abandoned by Standard of Bolivia in 1931. Tests have not yet been made because of extreme pressure.



It isn't the acid!

It's how the acid is used that counts!
Who uses it . . . where . . . and how?
How much to use—and why?

SELECTIVE ACIDIZING calls for selected men, materials, methods

To produce best results, it is now possible to direct acid and other well-treating chemicals into *selected* zones through use of the Dowell Electric Pilot. Selective acidizing is particularly advantageous in wells with high gas-oil ratios, high water-oil ratios, two or more pay zones, sands exposed above or below limestone, leaky casings, and wells that have been deepened.

The Dowell engineers who perform *Selective Acidizing* service are chosen for their ability and experience. They help operators plan the treatment for each well, choose the correct solvents, and use the Electric Pilot with other advanced techniques to achieve the best possible results.

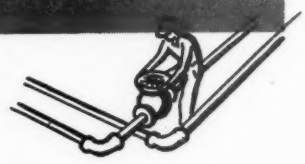
For Selective Acidizing, call Dowell. *Ask for your free copy of the new booklet describing Dowell Electric Pilot Services.* Ask also about Permeability Surveys, Water Locating, Mud Acid, Plastic Service and Chemical Scale Removal for heat exchange equipment. Dowell products include: Jelflake, Paraffin Solvents, and Bulk Inhibited Hydrochloric Acid.

OKLAHOMA EXAMPLE: *An Electric Pilot survey on a well previously acidized three times showed most of the permeability was in the middle pay zone. The well was selectively acidized using the Electric Pilot, the acid being directed into lower and less permeable sections. Results: Sustained flowing production of 250 BOPD on 1/64 choke with 600 lb. tubing pressure.*

DOWELL

DOWELL INCORPORATED • TULSA 3, OKLAHOMA
Subsidiary of The Dow Chemical Company

pipeline developments



● **PLAN INCREASE OF LINE CAPACITY.** Northern Natural Gas Company has plans to increase its natural gas transmission system capacity to 580,000,000 cu ft per day. FPC hearings begin June 16 in Washington, D. C.

Facilities proposed include construction of a new compressor station with installed capacity of 10,000 hp near Garden City, Kansas, and 320 miles of 26-in. pipe line extending from the new compressor station to Palmyra, Nebraska; 245 miles of 24-in. line to complete the existing partial line looping from Palmyra to Farmington, Minnesota; 17.3 of 20-in. line from Palmyra to a point in Saunders County, Nebraska; the installation of an aggregate of 8,200 hp units in existing compressor stations along the line; a dehydration plant and appurtenant equipment. Cost is estimated at $24,500,000. Permission was recently granted the same company to proceed with a $12,441,000 project.

● **COLORADO LINE SCHEDULED.** Colorado Interstate Gas Company of Colorado Springs, Colorado, plans construction of a line and compressor station and other facilities designed to increase the company's system capacity by 100,000,000 cu ft of natural gas per day.

The proposed facilities are 240 miles of 20-in. pipe line from Lakin, Kansas, to Denver, Colorado; an 8400 hp compressor station and dehydration plant at Lakin; 20 miles of 20-in. pipe line to serve as a by-pass around Denver to connect the proposed line with the company's existing pipe line; 170 miles of gathering lines from 4½ to 20 in. to be used in delivering gas to the proposed compressor station.

● **EMERGENCY FACILITIES PROPOSED.** Inability to procure the necessary pipe to construct a supply line to the Hugoton gas field was cited by Cities Service Gas Company as the primary reason for its application to FPC to construct alternate facilities in order to obtain a gas supply to meet peak day demands during the next two winters. As an emergency step the company proposes to build up the supply on the southern part of its existing system to the extent that the anticipated system capacity of 648,000,000 cu ft per day can be maintained. The company estimated its 1947-48 peak day supply of gas at 601,000,000 cu ft.

Facilities proposed by the company to enable it to take the new supplies into its system include 48 miles of 12-in. gas line extending from a point near Guthrie on its Oklahoma City line to the Drumright compressor station in Creek County, Oklahoma, extension of a portion of its southern system with 10.5 miles of 16-in. line into Grady County and an additional 15.6 miles of 16-in. pipe line to increase system capacity on the outlet side of the Tallant compressor station. Total construction cost is estimated at $1,490,683.

● **PREPARES FOR INCH DELIVERIES.** Temporary authority has been given by FPC for New York State Natural Gas Corporation to construct and operate facilities to enable it to receive deliveries from the Big and Little Big Inch pipe lines. These facilities would add up to 75,000,000 cu ft of gas per day to the company's present capacity.

The FPC has issued the company a temporary certificate of public convenience and necessity permitting construction and operation of a new 6000-horsepower compressor station and connections to cost an estimated $1,215,785 and 1.1 miles of 20-in. connecting lines to cost an estimated $98,000.

● **WORK IN PROGRESS ON TEXACO LINE.** Contract for the construction of a 172-mile product pipe line linking Hearne, Dallas, and Fort Worth, Texas, has been awarded to the Associated Contractors and Engineers of Houston, by The Texas Pipe Line Company, R. B. McLaughlin, president, stated.

Plans call for a 10¾-in. line from Hearne to a terminal site at West Dallas, a distance of 146 miles, and a 26-mile 8⅝-in. line from West Dallas to Fort Worth. W. C. Wells, Jr., Beaumont contractor, has been awarded contract for clearing and construction of levees, tank grades, roads and preparing the station site near Hearne. Work on this project has been started, while construction of the pipe line will start shortly.

● **POSTPONE TRANS-CONTINENTAL HEARING.** Postponement until September 29 has been made of hearing on the application of Trans-Continental Pipe Line Company, Inc., for authority to construct a gas transmission pipe line from Texas to Atlantic Seaboard. Postponement was granted at the request of the company. The $130,000,000 project includes 1380 miles of 26-in. pipe line from Texas to the East Coast, 296 miles of gathering lines, and 14 main compressor stations.

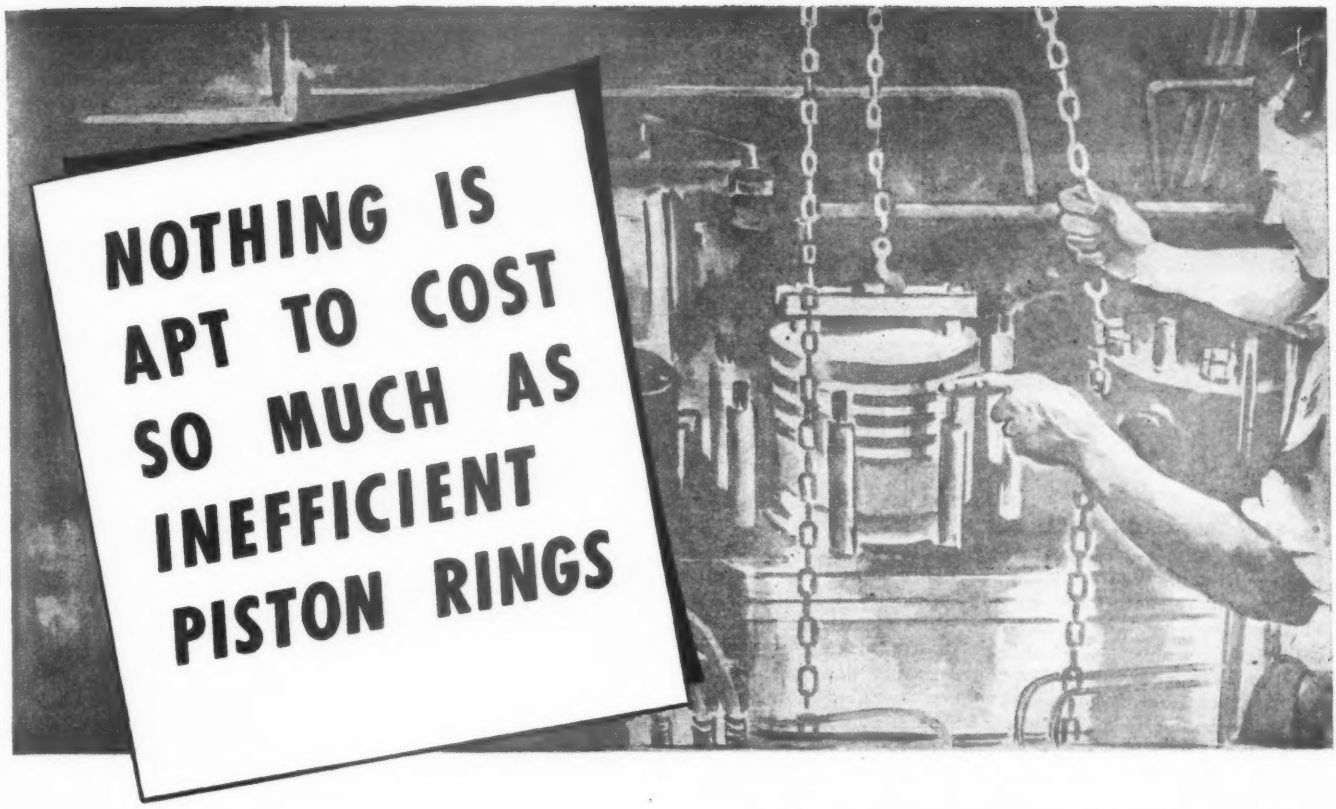
● **CONSTRUCTION BEGINS ON MAGNOLIA CARRIER.** Magnolia Pipe Line Company, Socony-Vacuum subsidiary, has awarded contracts for construction of its 650-mile, 20-in. crude oil pipe line from Corsicana, Texas, to Patoka, Illinois. The work begins this month.

Two major portions of the construction were awarded to Oklahoma Contracting Company, Dallas, Texas, totaling $21,168,000. The company will install 332 miles of 20-in. crude oil welded joint pipe line between Conway, Arkansas, and Patoka, Illinois, at $15,936,000. It will also install 109 miles of the line between Corsicana, Texas, and Hot Springs, Arkansas, at $5,232,000. The Eastern Construction Company, Inc., Dallas, has the contract for 108 miles of pipe line between Hot Springs and Little Rock, Arkansas, at $5,194,000. The remaining 111 miles between Little Rock and Conway, Arkansas, was awarded to H. C. Price Company, Bartlesville, Oklahoma, at $5,328,000. Cost of the entire project will total $31,680,000.

● **MONTERREY LINE READY FOR OPERATION.** Gas will start flowing into the $4,000,000 151-mile pipe line linking the South Weslaco field of Hidalgo County with industrial plants in Monterrey, Mexico, late in June, according to officials of Reynosa Pipeline Company, subsidiary of La Gloria Corporation of Corpus Christi, which owns the four wells in the field.

Construction of the 134-mile line from Monterrey to the Rio Grande has been completed. The 14-in. line will cross the river three-fourths mile east of Reynosa to connect with the line being completed on the Texas side.

● **HELICOPTER LAYS PIPE.** A rubber pipe line was laid by a helicopter at Army Engineer Center, Ft. Belvoir, Virginia, in 25 seconds with the helicopter flying 40 miles an hour at a height of 15 ft. The 400-ft hose, developed by the United States Rubber Company, was folded into a special container and released by the pilot at the press of a button. It is expected that this latest method of laying pipe line will have many military and civilian uses, particularly for conveying water and gasoline.



Cook Graphitic Iron Plain Rings feature: Excess carbon in the form of graphite flakes to ease the ring over dry spots in the cylinder—Porosity to facilitate spreading of lubrication—Rapid work-hardening ability to minimize friction, prolong life—Freedom from wear-inducing, steel-like inclusions (carbides).

...take "CYLINDER WEAR"

Cylinder wear results from the rubbing action of the piston rings against the cylinder wall. The rate of wear is influenced by many variables, but chiefly by the material of which the rings are made—just as the rate of wear of a shaft is mainly determined by the material in the bearing. Where you have rings of high friction materials you add to your operation expense sheet the hidden cost items of early cylinder replacement—higher and higher fuel consumption as wear progresses—lost power—frequent shutdowns for repairs.

Cook Graphitic Iron Rings are outstanding in their friction-reducing properties. Test after test both in field and laboratory has proven this indisputable fact. The exclusive material of which they are made and their process of manufacture enable them to keep friction and wear to a minimum and thus prolong cylinder life. Cook Rings are custom made for severe service conditions and occupy a unique position in this field.

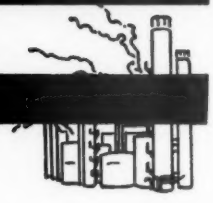
If your rate of cylinder wear is high, it will pay you to investigate Cook Rings. For the complete story, write today. ATTENTION DEPT. 5-C.

C. LEE COOK MANUFACTURING CO.
INCORPORATED
LOUISVILLE, KY.
BALTIMORE • BOSTON • CHICAGO • CLEVELAND
HOUSTON • LOS ANGELES • MOBILE • NEW ORLEANS
NEW YORK • SAN FRANCISCO • TULSA

Sealing Pressures — Since 1888

"Better Piston Rings for Higher Efficiency—through Metallurgy"

refining and natural gasoline activities



● **EXPANSION SCHEDULED FOR WICHITA PLANT.** Bareco Oil Company has concluded arrangements for expanding and modernizing its Wichita, Kansas refinery, according to an announcement released by V. R. Oakley, vice president in charge of manufacturing. The program includes installation of a new catalytic desulphurization-catalytic reforming unit, licensed by Phillips Petroleum Company; modernization of steam generating facilities; and expansion of refined products' storage. Consideration is also being given to additional facilities and equipment for recovery of propane and butane for LPG.

Total expenditures are estimated at approximately one-half million dollars. Koch Engineering Company, Wichita, Kansas, has contracted for the engineering and construction work for the reforming unit and the entire modernization program is scheduled for completion late in 1947.

● **SHAMROCK BUYS GASOLINE UNIT.** Purchase of the Magnolia Petroleum Company's Sunray gasoline plant was announced today by J. H. Dunn, president of The Shamrock Oil and Gas Corporation. The plant, three miles south of Sunray, Texas, was built in 1937 and has been operated by Magnolia since that time to process its natural gas production in the area.

Under the purchase arrangements, Magnolia will continue the operation of the plant with its employees for the present. Shamrock will install additional facilities, however, to increase the capacity of the plant.

● **CYCLING PLANT NEARS COMPLETION.** Operation of the Cranfield Cycling Plant, now being constructed about 18 miles east of Natchez, Mississippi, is expected to begin about August, it was stated by K. H. Crandall, president of the Mississippi Cycling Company. Crandall said that the plant will have a throughput capacity of approximately 100,000,000 cu ft of gas per day. It will use production from the Cranfield field, where The California Company is the principal operator.

The plant will produce propane and rectified condensate. The stripped gas will be injected back into the reservoir to maintain the pressure. About 50 employees will be required for the operation.

● **EXPANSION PROGRAM REVEALED.** Mid-Continent Petroleum Corporation has announced that plans are underway for a $3,500,000 expansion program in the Tulsa refinery of the company. The program includes a new catalytic cracking unit by M. W. Kellogg Company to supplement present thermal cracking facilities. Work is scheduled to begin about February, 1948, and about six months is expected to be required for completion. The expansion will increase the plant's capacity from about 35,000 bbl daily to 45,000 bbl.

● **CHEMICAL PLANT IN PROSPECT.** A $20,000,000 chemical plant to process hydrocarbons, especially natural gas and petroleum, into a wide line of commercial products is now being planned for the Gulf Coast and should be in operation in the next three years, Dr. Henry Hass, head of the chemistry department of Purdue University, revealed last month in Houston, Texas.

Dr. Hass said the new plant is being planned by the Commercial Solvents Corporation of New York. Dr. Hass is its consulting chemist. He declined to reveal the location of the plant but said it will turn out 100,000 lb of nitroparaffins daily of a total value of $25,000 as against a plant the concern now has in Peoria, Ill., now turning out 5000 lb. From nitroparaffins, he said, can be manufactured other things such as high explosives, solvents, insecticides, emulsifying and cleaning agents.

● **WAA RECEIVES OFFER FOR PLANT.** The War Assets Administration considered a $2,000,000 offer from the Eastern States Petroleum Company for the 100-octane gasoline refinery now operated under lease by the company in Houston, Texas.

● **TEXAS COMPANY TO ENLARGE REFINERY.** New and modernized equipment to be installed in the Tulsa, Oklahoma, refinery of The Texas Company will increase its capacity from 20,000 bbl to 30,000 bbl a day. The project, which calls for replacing the plant's two batteries of shell stills with eight stills to a battery and for replacing the present thermal cracking equipment with new, is expected to go into construction this summer or fall but the entire plans may not be completed for as long as two years, according to E. M. Reynolds, plant superintendent. A catalytic polymerization unit, an acid treating and a sweetening plant, additional steam-generating and water-cooling facilities, and other equipment will be added. The cost will run into several million dollars, depending upon conditions, company officials said.

● **SPECIFICATIONS FOR JET FUEL REVEALED.** The navy is actively accumulating data to refine further specification requirements for its new jet fuel, according to a paper presented by E. L. Klein, fuels and lubricants branch of the power plant division of the bureau of aeronautics, Navy Department, before the summer meeting of the Society of Automotive Engineers at French Lick, Indiana.

On the basis of the national advisory committee for aeronautics' availability data and engine operational requirements, the armed services have evolved the following specification requirements for the jet fuel:

1. Freezing point, not higher than 76 F.
2. Residue after evaporation by the air jet method shall be not greater than 5.0 ml per 100 ml of fuel.
3. Aromatic content shall not exceed 30 per cent by volume.
4. Sulphur content of the fuel shall not exceed 0.50 per cent by weight.
5. The fuel shall be substantially immiscible with water.
6. The accelerated gum content shall not exceed 8.0 mg per 100 ml of fuel (16 hr test).
7. The final boiling point (end point) shall be between 550 F and 600 F.
8. Viscosity: Temperature 40 F; viscosity 6.0 (max); temperature 100 F, viscosity 0.8 (min).
9. Reid vapor pressure at 100 F shall be between 5 and 8 psi.
10. Net heat of combustion, 18,400 Btu per lb (min).

● **PROPOSE REDUCTION IN QUALITY GASOLINE.** A suggestion was made that the oil and gas division of the Interior Department advocate reducing the quality of gasoline to increase the quantity available for use in the shortage that is predicted. The proposal was made at the meeting of the National Council of Independent Petroleum Associations in Chicago by Gordon Duke of Southeastern Oil Company, council chairman. The meeting discussed various elements of the supply situation.

● **TEXAS CITY DAMAGES ESTIMATED.** Although it will be impossible to estimate total losses of oil companies in the Texas City disaster for some time the following figures give an idea of the losses: Monsanto Chemical plant was built by the government at a cost of $19,000,000 and last year was sold to the company for $9,000,000. Government still owns and has listed as surplus: American Liberty 100-octane plant, built at a cost of $12,500,000; Republic Oil Refining 100-octane plant, costing $11,700,000; Pan American Refining unit, costing $3,000,000; and Southport Petroleum butadiene plant, costing $1,500,000.

Crude oil storage farms may never be rebuilt to same capacity, due to scarcity of sheet steel. Some of the plants may not be rebuilt.

P 775.

THE Petroleum Engineer

JUNE, 1947

Cycling plant includes innovations

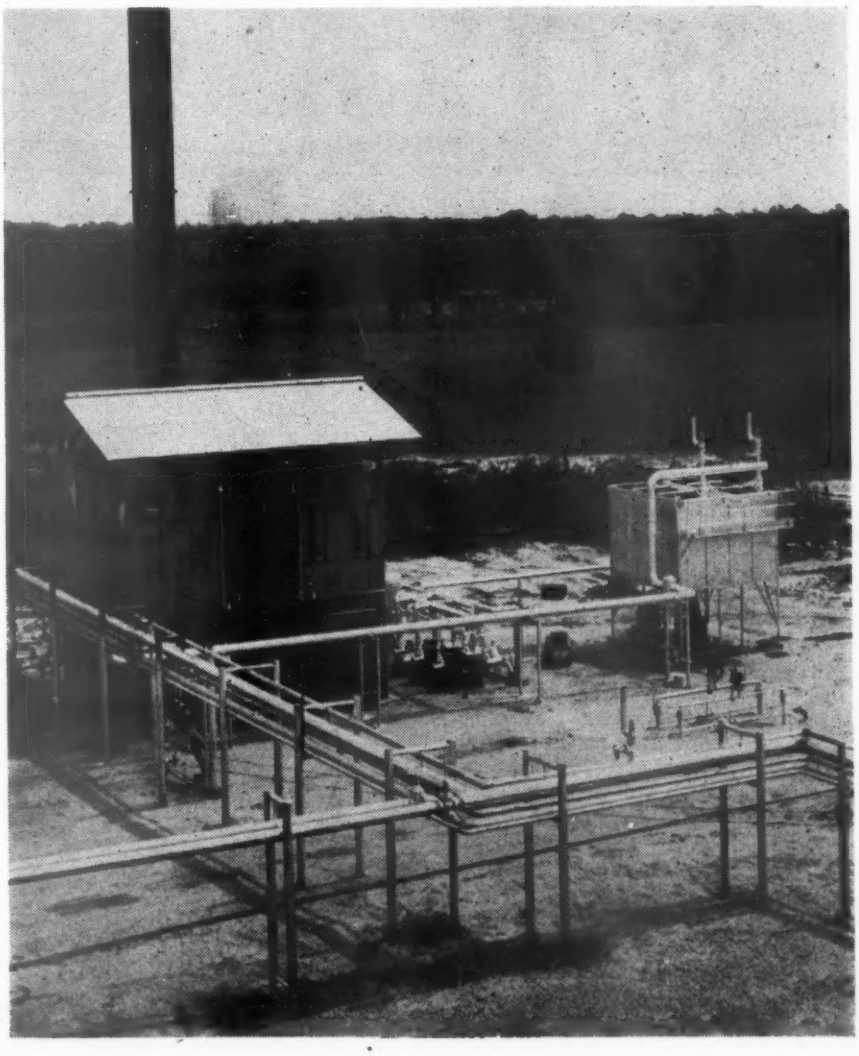
By FRANK H. LOVE, *Managing Editor*

THE Chapel Hill cycling plant constructed and being operated by the Lone Star Producing Company through agreement with the Chapel Hill Operators' Committee, is now in operation 12 miles east of Tyler, Texas. Designed for a total capacity of 55,000,000 cu ft a day, the overall program was divided into two parts. Processing equipment has been installed to handle the ultimate total load; however, compressor equipment to return residue gas to the producing formation is provided for an initial load of 35,000,000 cu ft. At some later date this compressor capacity will be increased to handle additional gas.

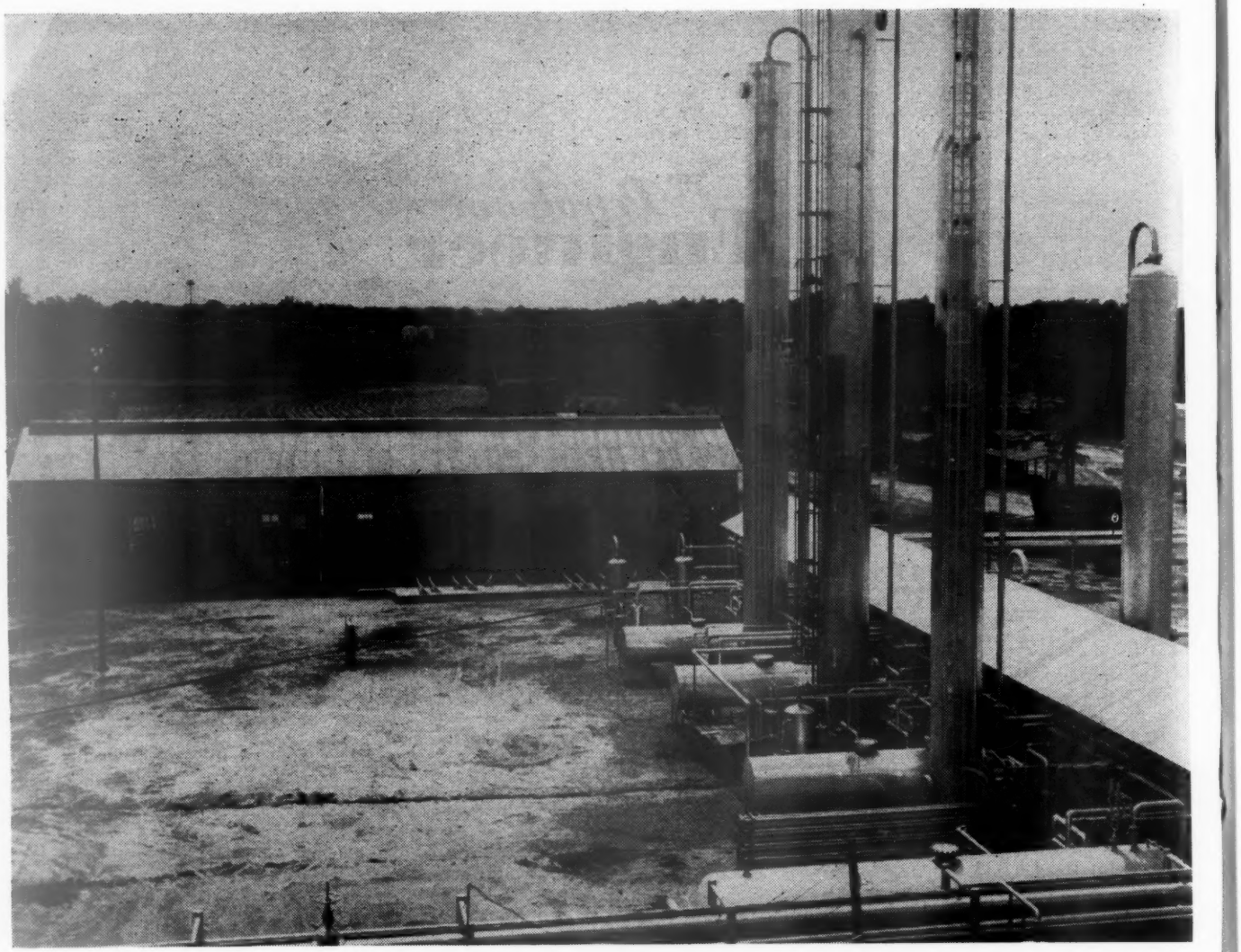
EXCLUSIVE

The overall plant design is for extraction of 80 per cent of the butanes and substantially 100 per cent of the pentanes plus, with no vapors being flared. Products now being manufactured are 98 per cent pure propane, an 18-lb RVP gasoline, kerosine, and commercial butane.

The Chapel Hill installation was designed to embody the most recent in cycling plant equipment and practices, and several features have been included that are decided departures from the customary. Layout of the plant provides for its operation by three men from a central corridor. Aside from the office and laboratory building, there are only two buildings—the compressor house



Steam is generated by two 252-hp water-tube boilers (left) that operate at 300-psi pressure. At right is the air-cooled steam condenser.



The plant is manufacturing natural gasoline, propane, butane, and kerosine. In the right foreground can be seen a part of the processing towers and in the background is the compressor building. Control of the plant is from a central corridor, whose roof can be seen at right.

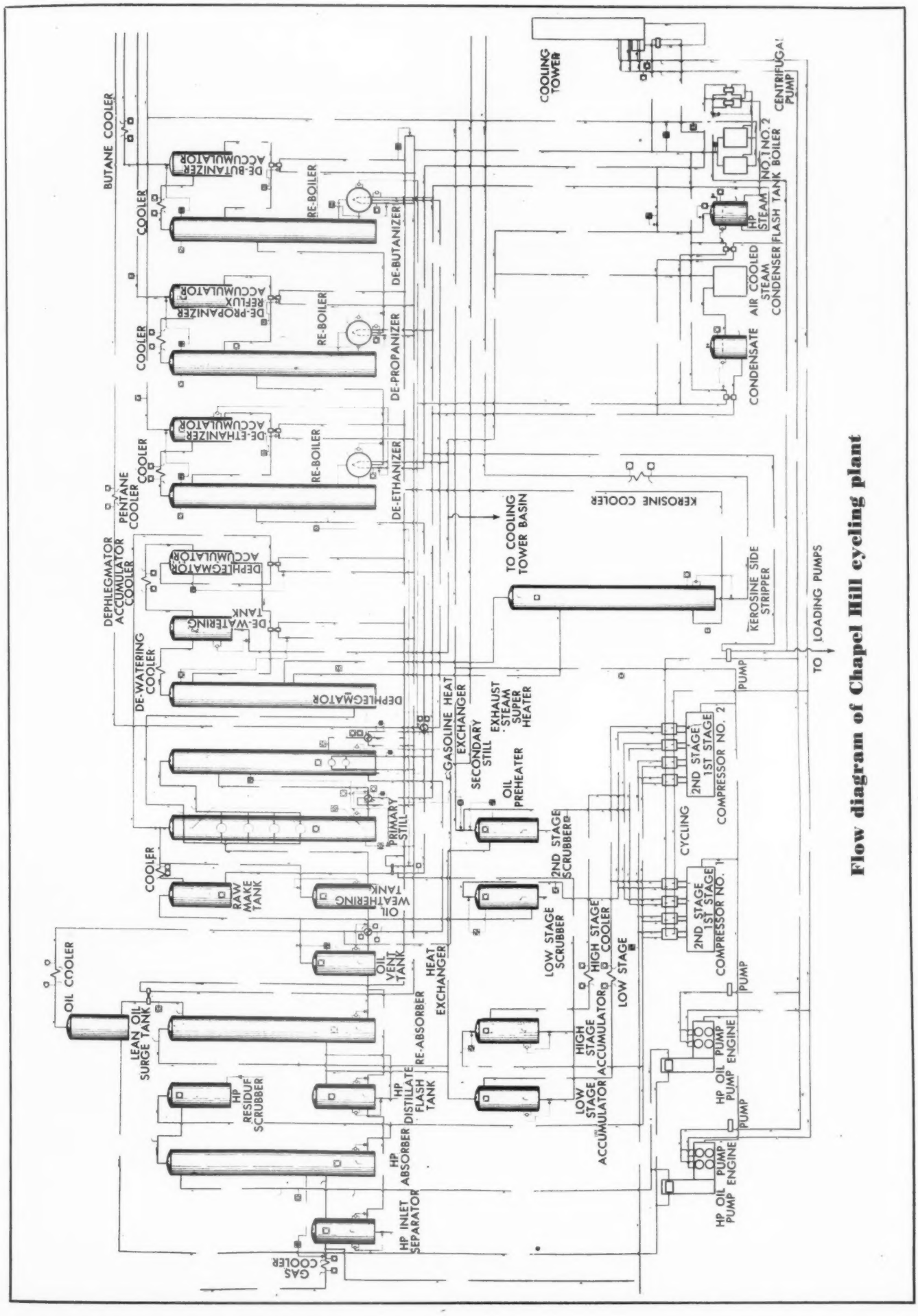
and the generator house. Boilers and process pumps are not housed. This decision was reached after careful consideration of the hazards involved, hazards that may result when engines and pumps are housed together in a single building. Consequently, pumps and their prime movers are placed near the units that they serve.

Instrumentation also is highly localized, in that each vessel requiring control has a control instrument situated immediately in front of it in a weatherproof housing.

Moreover, interlocking alarms have been provided so that not only hazardous conditions, but also departures from normal operating conditions, are immediately brought to the operators' attention by means of visual or audible indicators, or both.

All relief valves are dual installations

Vertical pumps that are driven by electric motors circulate water over the cooling tower.



Flow diagram of Chapel Hill cycling plant

Chapel Hill storage.

Product	No. of tanks	Size	Tank capacity, bbl
Propane	1	8″ x 50′	335
Butane	9	10′ x 40′	570
Kerosine and fuel oil	5	21′6½″ x 16′1″	1,000
Gasoline	6	12′ x 50′	1,000
	3	45′ x 35′7″	10,000
Water	2	21′6½″ x 24′1½″	1,500

having block valves between the relief valve and the source of pressure. These block valves can be locked open or shut and each relief valve is capable of handling the maximum anticipated load. This is a marked departure from general plant practice.

Hot vessels and lines have been insulated and covered with corrugated aluminum.

The following is a description of the gas flow and processing procedure.

● **High pressure gas system.** Gas is brought in from the field at wellhead pressure, passed through inlet gas coolers, and reduced in pressure by a regulator to 1500 psi. Condensate is withdrawn in an inlet separator that operates at 1500 psi and the gas is discharged to the high pressure absorber. Residue gas from the top of the absorber passes through the residue scrubber and into the suction of two 800-hp compressors. These units compress the gas to 2700 psi for return to the Paluxy producing formations through two injection wells.

● **Processing cycle.** The condensate that was removed from the gas stream in the inlet separator is flashed through a distillate flash tank and then goes to the base of the 500-psi reabsorber. Lean oil is circulated over the high pressure absorber at a rate of 280 gpm by means of two gas-engine-driven reciprocating pumps. Rich oil from the base of the high pressure absorber is mixed with the previously mentioned condensate from the inlet separator and flashed through a 500-psi reabsorber.

Gas processed in the reabsorber consists of vapors from a 300-psi cold rich oil flash, compressed raw make tank vapors, and vapors generated by flashing condensate and rich oil from 1500 psi to 500 psi. Reabsorber operating conditions are such that substantially 100 per cent butane extraction is assured.

Tankage at the cycling plant for storage of manufactured products consists of six 50,000-gal gasoline tanks, four 24,000-gal butane tanks, two 1000-bbl kerosine tanks, and one 1000-bbl fuel oil tank.

The total oil and distillate stream from the base of the reabsorber exchanges heat through conventional heat exchangers and goes to the primary still, which operates at 200 psi.

Sufficient methane, ethane, and propane are discarded in the primary still to assure total condensation at 45 psi of the secondary still overhead vapors.

Primary still overhead vapors at 200 psi are cooled in condenser coils and the recondensed vapors and liquid fed to the raw make tank.

Oil from the base of the primary still is preheated through a shell-and-tube preheater using 300-psi steam and is introduced into the secondary still. Lean oil is withdrawn from the base of the secondary still, passed through shell-and-tube heat exchangers, cooled in lean oil coolers in the cooling tower, and thence to the suction of the high pressure oil pumps and reabsorber oil pumps.

Shell and tube heat exchangers.

Service	Surface, sq ft	Size
Raw feed—debutanizer bottoms exchanger	808	3″ x 21′
Rich oil preheater	1430	24″ x 23′
Oil heat exchangers	7150	24″ x 23′
Exhaust steam superheater	575	16″ x 19′-6″
Deethanizer reboiler	750	48″ x 20′
Depropanizer reboiler	750	48″ x 20′
Debutanizer reboiler	750	48″ x 20′

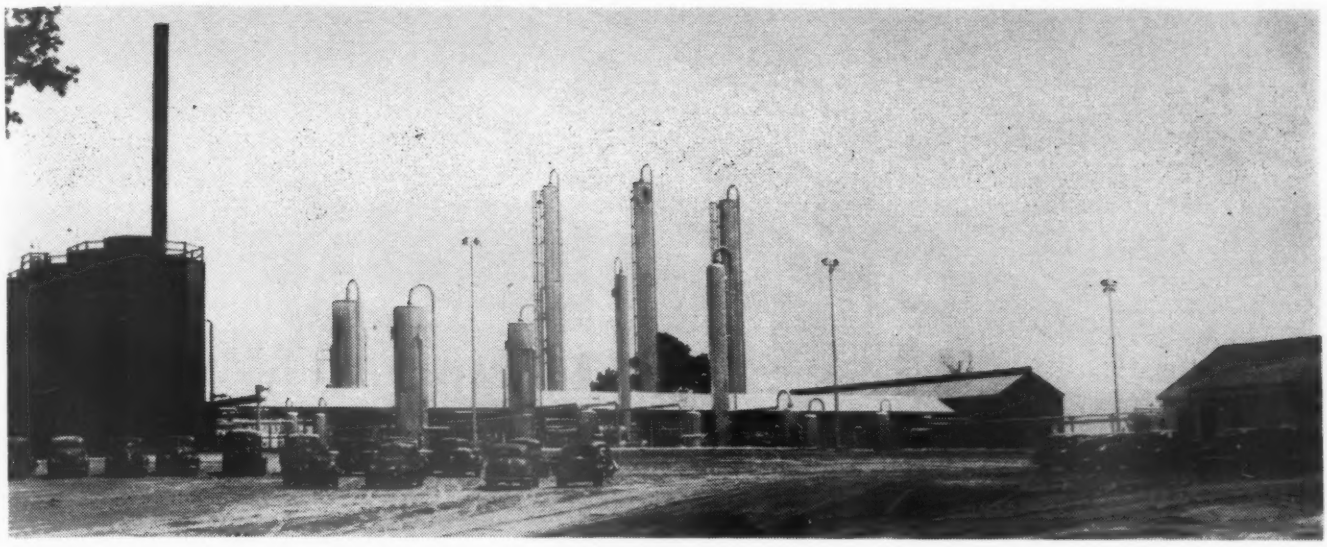
Vapors from the top of the secondary still interchange heat by means of two tube bundles in the primary still where partial condensation takes place. The mixture of vapors and liquid from the outlet of the primary still is sent to the dephlegmator. Overhead from the dephlegmator is totally condensed in atmospheric type cooling sections in the cooling tower. Part of this condensate is used as dephlegmator reflux and the excess is pumped into the raw make tank at a pressure of 200 psi. Vapors from the raw make tank go to the first stage suction of the recompressors. A side stream from the dephlegmator is used as feed to the kerosine side stripper.

Residue gas from the 500-psi reabsorber is used as plant fuel and the excess, combined with first stage discharge vapors, forms the second stage suction. The second stage discharges at a pressure of 1500 psi, the gas being cooled in atmospheric sections in the cooling tower and then fed to the suction of the compressors, which return it to the producing formation.

Gasoline from the raw make tank interchanges heat with debutanizer bottoms and is fed to the deethanizer, which operates at a pressure of 350 psi. Over-

Chapel Hill vessel schedule

Service	Size	Working pressure, psi	Trays	Tray spacing, in.
Inlet separator	54″ x 7′	1500	X	X
H. P. absorber	60″ x 43′	1500	16	24
Residue scrubber	54″ x 7′	1500	X	X
Reabsorber	36″ x 43′	500	15	24
Rich oil vent	48″ x 7′	160	X	X
Rich oil flash	48″ x 7′	250	X	X
Primary still	72″ x 28′8″	200	6	24
Secondary still	90″ x 30′	100	8	24
Dephlegmator	90″ x 35′	100	9	24
Deethanizer	48″ x 70′	350	30	24
Depropanizer	54″ x 69′-3″	600	30	24
Debutanizer	60″ x 70′	135	30	24
Deethanizer accumulator	36″ x 7′	350	X	X
Depropanizer accumulator	20″ x 7′	290	X	X
Debutanizer accumulator	20″ x 7′	135	X	X
H. S. accumulator	36″ x 7′	1500	X	X
H. S. scrubber	36″ x 7′	500	X	X
L. S. accumulator	36″ x 7′	500	X	X
L. S. scrubber	36″ x 7′	500	X	X
Kerosine side stripper	30″ x 7′	100	X	X



General view of Chapel Hill cycling plant. At the left is the cooling tower, in the center the processing area, and to the right of this the compressor building. At the far right can be seen a part of the office building.

head vapors from the deethanizer are partially condensed through atmospheric sections in the cooling tower. Uncondensed vapor from the accumulator is used as boiler fuel and the condensate is returned to the column as reflux.

Deethanizer bottoms are fed to the depropanizer, which operates at a pressure of 290 psi. Specification propane is withdrawn from the condensed overhead of the depropanizer and the depropanizer bottoms are fed to the debutanizer. A mixture of isobutane and n-butanes are withdrawn from the top of the debutanizer and the debutanizer bottoms exchange heat with raw feed to the deethanizer. The debutanizer bottoms are cooled in the cooling tower and sent to storage.

● **Steam system.** Plant steam is generated by two 252-hp water-tube boilers that operate at a pressure of 300 psi. The steam system is designed to operate at substantially 100 per cent condensate return. An air-cooled condenser is used to condense low pressure exhaust steam.

● **Electrical system.** Plant electricity is generated by two 156-kva gas-engine-driven generator units, which are arranged in such a manner that they can be used either singly or in parallel.

● **Cooling tower.** The cooling tower is the induced draft type. The tower consists of five cells with four bays per cell and was designed to dissipate a total of 50,000,000 Btu per hr. Electric motor-

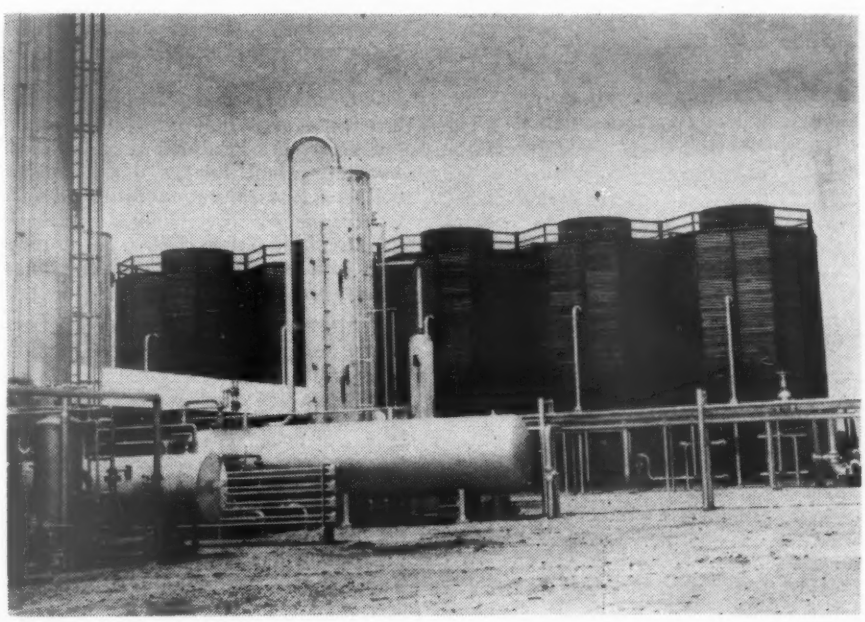
Inlet gas composition.

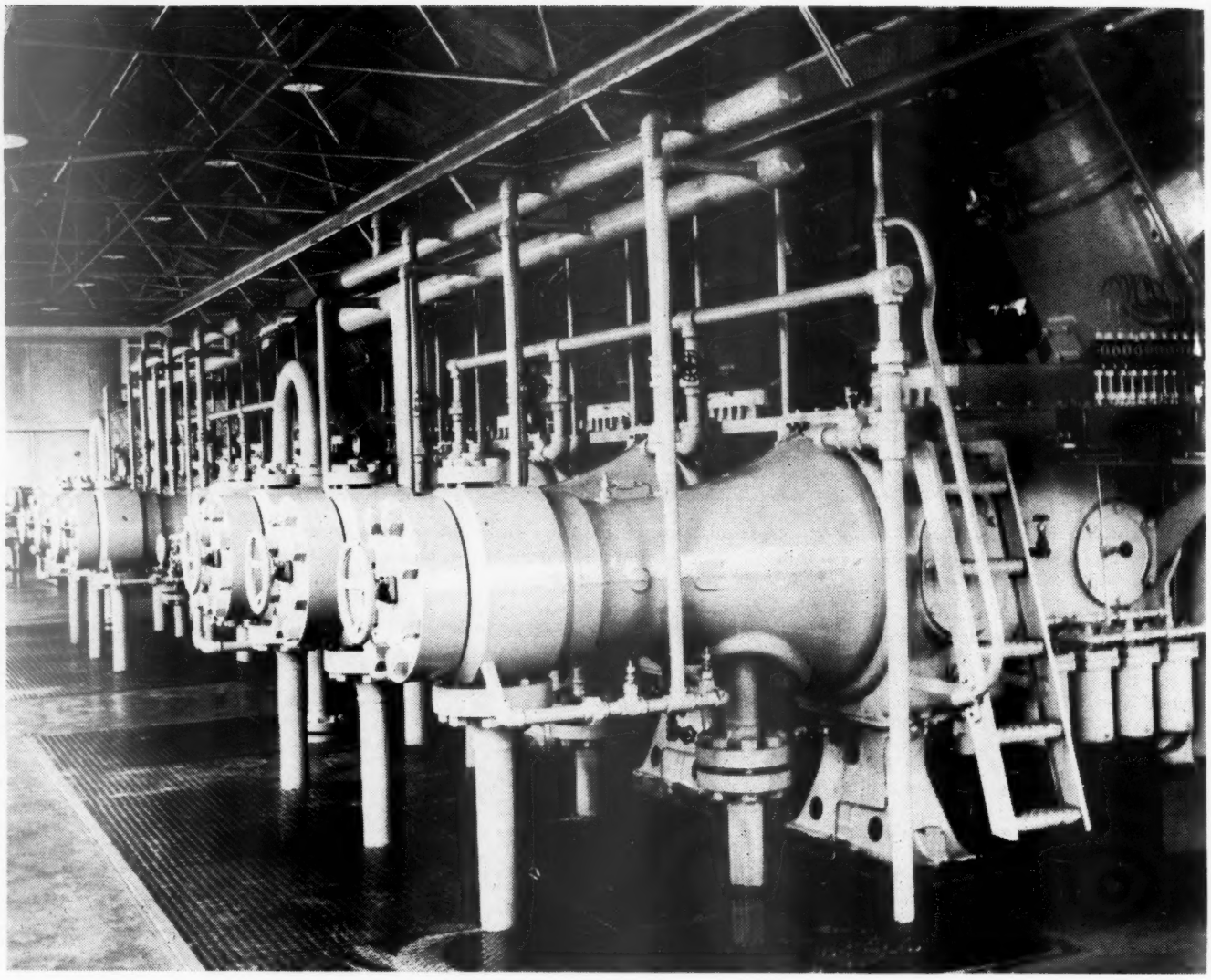
Component	Mol per cent
Methane	79.27
Ethane	8.47
Propane	4.46
Isobutane	1.14
N-butane	1.87
Isopentane	0.78
N-pentane	0.83
Hexanes plus	3.18
	100.00

Chapel Hill pump schedule.

	Size	Type	Suction pressure, psi	Discharge pressure, psi	Gpm	Fluid
Reabsorber oil	14″ x 6″ x 12″	Reciprocating	30	525	50	M. S. oil
H. P. oil	4″ x 12″	Reciprocating	30	1650	140	M. S. oil
Dephlegmator reflux	10″ x 7″ x 20″	Reciprocating	30	50	150	Gasoline
Raw feed	14″ x 9″ x 20″	Reciprocating	200	375	134	Gasoline
Secondary accumulator	10″ x 7″ x 20″	Reciprocating	30	225	90	Gasoline
Deethanizer reflux	8″ x 7″ x 16″	Reciprocating	350	375	68	$C_2 + C_3$
Depropanizer reflux	8″ x 7″ x 16″	Reciprocating	290	315	60	Propane
Debutanizer reflux	8″ x 10″ x 20″	Reciprocating	135	160	168	Butane
H. P. condensate	5″ x 5″ x 12″	Reciprocating	30	60	25	Water
L. P. condensate	5″ x 5″ x 12″	Reciprocating	10	35	25	Water
Raw water	5″ x 5″ x 12″	Reciprocating	5	35	25	Water
Butane loading (plant)	6½″ x 6″ x 12″	Reciprocating	30	250	50	Butane
Propane loading (plant)	14″ x 6″ x 12″	Reciprocating	100	500	50	Propane
Gasoline loading (plant)	12″ x 7″ x 16″	Reciprocating	5	250	75	Gasoline
Butane loading (rack)	1½ MRV	Centrifugal	30	150	100	Butane
Gasoline loading (rack)	1½ MRV	Centrifugal	0	50	300	Gasoline
Kerosine loading (rack)	1½ RVH	Centrifugal	0	75	75	Kerosine
Cooling tower circulation	3 RL	Centrifugal	0	25	2500	Water
Engine jacket	5 CRVL	Centrifugal	0	30	900	Water
Boiler feed	1½ TUT-7	Centrifugal	50	350	90	Water

In background is induced draft type cooling tower. This tower has five cells of four bays per cell; it dissipates 50,000,000 Btu an hour.





Residue gas from the top of the absorber is discharged to the suction of two 800-hp compressors, where it is compressed to a pressure of 2700 psi for return to the Paluxy producing formations through two injection wells.

driven vertical pumps are capable of circulating 7500 gpm of water over the tower. Induced draft is provided by five 15-hp motor-driven fans.

Plant water is supplied by a well on the plant site that is rated at 500 gpm.

● **Tankage.** Tankage at the plant for storage of manufactured products consists of six 50,000-gal gasoline tanks, four 24,000-gal butane tanks, two 1000-bbl kerosine tanks, and one 1000-bbl fuel oil tank.

Atmospheric type cooling sections.

Service	Working pressure, psi	Surface, sq ft
H. P. gas coolers	2,500	1,300
Jacket water coolers	100	1416
H. S. vapor coolers	1,600	180
L. S. vapor coolers	525	261
Primary still vapor	250	
Primary still vapor	250	2,895
Debutanizer reflux condenser	150	
Debutanizer reflux condenser	150	3,696
Depropanizer reflux condenser	325	2,403
Deethanizer reflux condenser	500	1,278
Dewatering condenser	125	534
Secondary still condenser	125	1,424
Oil coolers	125	3,204
Pentane plus coolers	150	262
Butane coolers	150	126
Kerosine coolers	125	84
		19,063

● **Loading rack.** Approximately five miles northwest of the plant, on the St. Louis-Southwestern Railway, is a 24-car loading rack. Loading pumps consist of explosion-proof motor-driven units. At this location, also, is a lead blending plant having a capacity of 8500 gal, and storage facilities. The latter consist of three 1000-bbl kerosine storage tanks, five 24,000-gal butane storage tanks, and three 10,000-gal gasoline tanks.

● **Construction by company personnel.** Construction of the plant was by company personnel. Engineering and design work was done in the Dallas office by gasoline department personnel, consisting of Fred H. Townsend, superintendent of gasoline plants; John Kindle, assistant superintendent of gasoline plants, and J. L. Thompson, chief chemist. Assisting were C. A. Holtman and Paul Brown of the engineering department.

C. O. Diller, chief draftsman and telephone superintendent for the transmission division, designed the eletrical facilities. Installation of the electrical equipment and wiring of the plant was by M. W. Crowder, superintendent of the Joshua compressor district, and assisting him were Seth Davis and Charles Putnam of the Joshua plant.

Field supervision of construction was under the direction of J. L. Hamilton, who is superintendent of the plant since it was put on stream; F. D. Ford, assistant superintendent; Chester Rogers, East Texas district superintendent for Lone Star Producing Company's gasoline department; A. B. Hemphill, construction engineer; H. H. Saunders, maintenance foreman; R. H. Hassell, field supervisor for the stores department, and Joe Giuffre, party chief for the engineering department.

Field lines connecting the plant to the producing and injecting wells were laid by Oklahoma Contracting Company. Supervising this phase of the work for Lone Star was Earl Miller, construction foreman, and Vaughn Sears, heavy equipment operator. ★ ★ ★

Thermal surveys applied to oil field problems

By HENRY G. ABADIE, *Division Petroleum Engineer,*
Union Pacific Railroad Company

Two novel applications of thermal logging have been made by an operator in the Kettleman Hills North Dome field, California, to solve drilling and production problems. Each type of application is characterized by the degree of control that may be used to insure the success of the survey. One application involves a method whereby small leaks may be located to produce a temperaure anomaly at the point of leak. The second application is one that enables the location of a point or area of lost circulation in a drilling well and thereby facilitates cementation at the point of lost circulation.

EXCLUSIVE

Thermal work of the two types mentioned was made under conditions that resulted in the producing of large temperature anomalies. Both types of problems are particularly adapted to accurate solution by thermal means at low cost to the operator. It will be recognized in the cases illustrated that the prevailing conditions encountered were such as to be generally favorable for successful thermal work. It is important that the elements of the problem be understood in order to evaluate the best means to insure the success of the work.

Thermal survey work has gained limited acceptance only in its applicability to oil-field problems. As a more general understanding is gained of the thermal principles involved, it is believed that thermal survey work will be used more extensively as an oil-field tool.

● **Method of locating leaks in casing or tubing in a well.** This method was developed to locate a water leak in a water string in well "A." The rate of water entry through the leak was so small that "water witching" or pressure testing could not be applied successfully. Gas-lift gas had previously been observed issuing at the surface on the outside of the water string indicating that gas could be pumped around the string of casing through the point of leak. The following is a description and analysis of the thermal survey.

"Well "A" had a protective string of 11¾-in. casing cemented at 5533 ft; 8⅝-in. water string cemented at 7029 ft; 6⅝-in. liner hung 6998-8225 ft, perforated overall from 7419-8225 ft. The 3-in. tubing had previously been pulled to 4437 ft for an unsuccessful flowing "waterwitch" run.

A portable compressor was used to depress the column of salt water between the 8⅝-in by 11¾-in. annulus to the point of leak, thereby establishing a flow of gas down the annulus and into the 8⅝-in. casing. While gas lifting the well in this manner, the well was produced through the 8⅝-in. casing. At the time of the run the well was producing at a rate of 475 bbl of gross fluid, 8.5 per cent cut; circulated gas, 1150 M cu ft, formation gas 500 M cu ft; 835 psi tubing pressure, 645 psi casing pressure, 1800 psi (estimated) input circulation pressure. The well was gas

FIG. 1

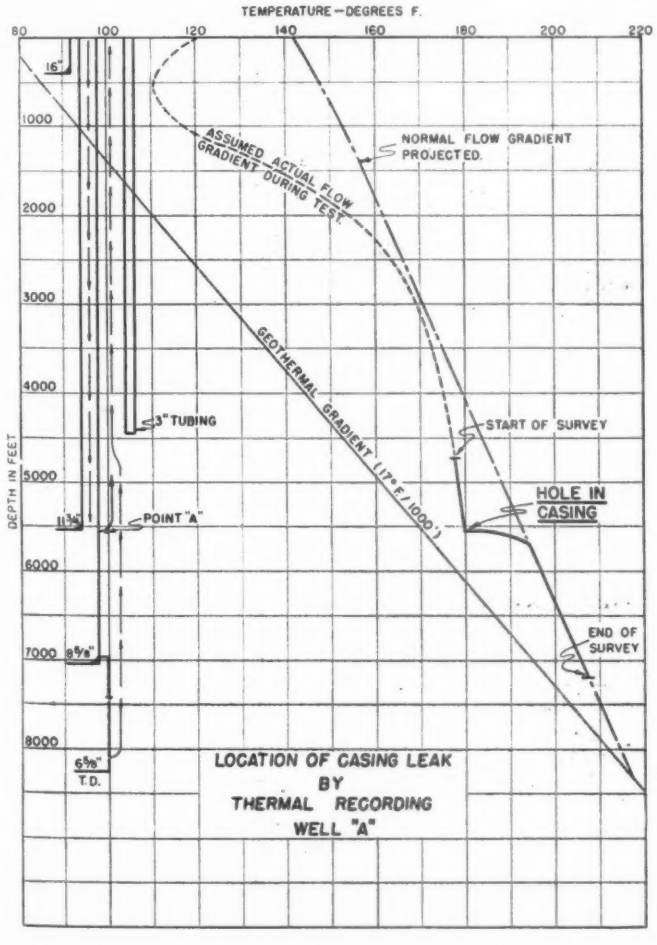
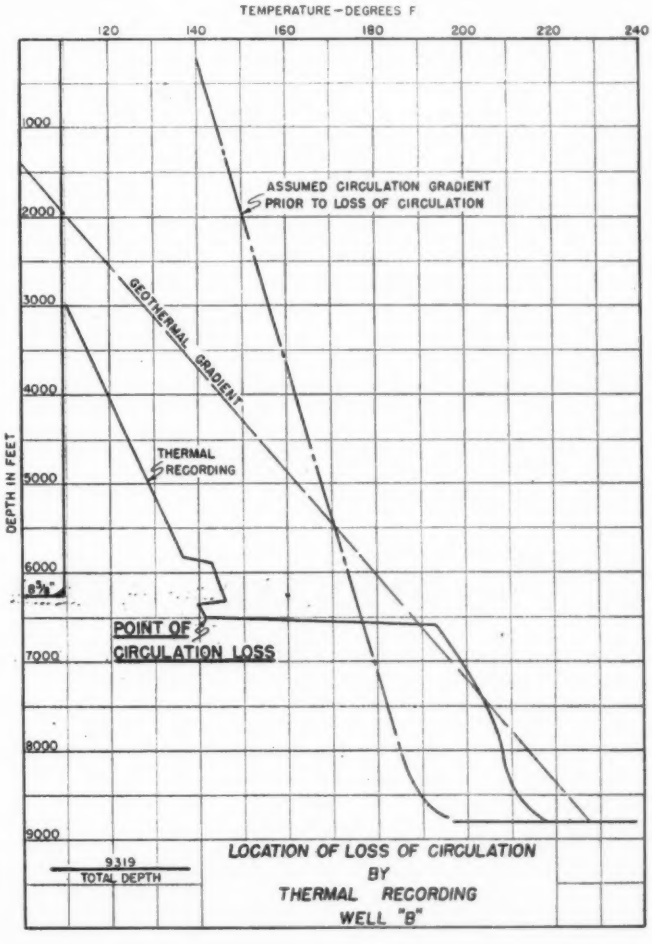


FIG. 2



lifted in this manner for approximately 18 hr to insure equilibrium conditions. It is believed that an adequate temperature anomaly was established in 5 or 6 hr after breaking circulation through the leak.

One temperature traverse was made to record in the interval from 4700 ft to 7200 ft. The survey indicated a marked temperature anomaly of 13 F at 5535 ft. (See Fig. 1). Using a packer, the location of the leak was confirmed as being between 5538 ft and 5540 ft by circulating 2½ cu ft of fluid per min under a pressure of 2000 psi. From subsequent thermal work, it may be stated that the same anomaly would have been recorded had the tubing shoe been below the point of leak.

The continuous recording instrument used is a self-contained precision unit that records on a high temperature photographic film. The film permits projection on a greatly enlarged scale, which facilitates interpretation of the survey record.

The completed survey was given on a scale of 1 in. equals 25 ft. In Fig. 1 the survey has been redrawn to permit inclusion of the entire survey from 4700 ft to 7200 ft. The variation from a straight line above and below the point of anomaly did not exceed 2 F from the straight lines shown in Fig. 1.

It is significant that the temperature change was effected while gas lifting a large volume of fluid from the well. Otherwise the anomaly would have been even more pronounced had this production been bridged off for the survey. As no temperature survey was made under static conditions, it is inferred from the intersection of the geothermal gradient and the flow gradient (projected) that the well was producing some or all of the fluid from bottom. The flow gradient established below the anomaly was projected in a slightly curved line to the surface. This would correspond approximately to conditions in the well prior to circulating gas through the leak. By circulating gas through the leak, point A, the entire gradient above that point is changed.

As a complete traverse was not made on this survey, for completeness in making this analysis it is necessary to assume a flow gradient in the upper part of the hole. The hot gas leaving the compressor is subjected to an initial cooling as it expands into the casing annulus. As it moves down the annulus, the gas reabsorbs heat from the fluid flow in the 8⅝-in. casing until it reaches the point of the leak (point A). In moving through the hole in the casing the gas expands, resulting in a cooling effect. The degree of cooling will be primarily a function of the volume of gas and the pressure drop through the point of leak. If production had been bridged off so that the produced fluid would have consisted of a small volume of salt water that accompanied the gas entry, a similar temperature change would have occurred in a temperature range below that corresponding to the geothermal temperature. Under those conditions the temperature change of the gas going down the hole would be dependent mainly on the earth temperatures. Regardless of direction of temperature change while going in the hole, i.e., cooling or heating of ingoing gas, a satisfactory temperature change may be obtained if the pressure drop is adequate for the volume of gas circulated. With cool gas in cool holes or at shallow depths, the freezing of hydrates may result.

Thermal work of this type for the location of leaks should prove successful under widely varying well conditions. A particular advantage of this work permits determination of the point of leak without disturbing the well. This permits the operator to plan the necessary mechanical work before entering the well.

● **Method of determining point of lost circulation in a drilling well.** Conditions encountered in the drilling of 10,000-ft wells resulted in a decision to locate points of lost circulation in a drilling well by means of a thermal survey and thereby eliminate the costliness of random cementation. Such work proved highly successful and economically feasible. In three wells a primary shut-off was made at the top of the first commercial oil and gas sand at approximately 7200 ft. The upper zones (Temblor) were then penetrated with low-weight drilling fluids. In penetrating the Kreyenhagen shale between 8,400-10,000 ft, it was necessary to increase the mud weight substantially to control the high pressure gas contained in Kreyenhagen fractured shale sections.

While penetrating the Temblor, circulation would be lost at various points. From a knowledge of general conditions and position in the section at time of losing circulation, the point of loss could be frequently inferred accurately. As drilling progressed into the Kreyenhagen shale and the mud weight was built up, loss of circulation was not uncommon. The point of loss could then be anywhere in a 1200-1500-ft Temblor section.

An illustration of one of the surveys is shown in Fig. 2. Casing of 8⅝ in. diam had been set at 6286 ft. While drilling at 9319 ft, circulation was lost completely. It required 185 bbl of mud to fill the hole. Due to an elapsed time of approximately 7 hr, 100 bbl of mud was pumped in and forced away just prior to the survey in order to have a pronounced temperature anomaly at the point of loss. It will be seen from Fig. 2 that this was an unnecessary precaution since an abnormally high temperature change of 52 F was recorded. It had been assumed that the hole temperature at the time of the survey approximated the geothermal gradient above and below the leak. By pumping 100 bbl of mud, approximately 1600 lineal ft in the 8⅝-in. casing, it was estimated that the gradient above the point of loss would retain the same slope but the temperature would be lowered approximately 17 F at all depths above the point of loss. It is of interest to note that temperature values below the point of loss approximated the geothermal gradient.

The pronounced log in the curve below 8000 ft is apparently due to the solid shale body below that depth.

In general, once the point of loss of circulation was established in the above manner, effective steps could be taken to plug the point of loss by cementation. Knowledge of the point of loss is of particular value where caution dictates the use of limited quantities of cement. With this knowledge, placement of all the cement was effected through open end drill pipe hanging a short distance, 50-100 ft, above the point of loss of circulation.

The author wishes to express his appreciation to Clarence R. Dale for his guidance and many helpful suggestions in thermal survey work. ★ ★ ★

P 094.81

HOW TO OPERATE A SMALL BOILER

By **W. F. Schaphorst**

MOST owners of small boilers are inclined to believe that such boilers cannot be operated at high efficiency and that only "large" boilers can be efficient. They think that small boilers are naturally wasteful of fuel and comparatively expensive to operate per horsepower and that "nothing can be done about it." They think that the boiler itself is not at fault, nor the fireman, nor anybody else. They believe that the fault is simply that the boiler is small.

But they are wrong. Small boilers *can* be operated efficiently. Inefficient performance is usually due to blind operation owing to the fact that no visible guides are provided for the fireman. Give the fireman the proper recording devices and operating indicators and if he is at all conscientious he will quickly step up the efficiency of the boiler and make the recorders pay for themselves and earn worthwhile dividends in addition. There are recorders on the market that show steam flow, air flow, and flue gas temperature at a glance. It is not necessary for the fireman to do any guessing with such records before him. He will soon know by observing the records whether the baffles leak, whether the tubes are dirty, whether the setting leaks, whether too much air is used, etc. Give your small boiler the same consideration that you would give to a larger boiler and you will find that the small boiler, too, can operate at high efficiency. ★ ★ ★

Selecting storage tanks for pipe line service

By D. A. LEACH, Chicago Bridge & Iron Company

PIPE-LINE terminal storage tanks constitute a large part of pipe-line investment. There are many types of tanks and systems available for pipe-line station service that can be used to advantage. For the benefit of the engineer designing a pipe-line system, there should be an accurate method available to arrive at the proper type of tank for each set of operating conditions. This article, therefore, will attempt to outline a sound method of arriving at an economic selection for pipe-line tanks.

EXCLUSIVE

● **Required initial data.** In order to reach a solution for any terminal tank problem, the following information is necessary:

1. Product to be handled. Description and vapor pressure at 100 F (gasoline, crude oil, or natural gasoline).
2. Location of station to determine temperature variations from Weather Bureau data.
3. Volume of throughput for each grade of product.
4. Volume of total storage required for each grade of product.
5. Dependable evaporation loss data from which yearly average loss for each type tank may be computed.
6. Estimated cost of the various types of tanks or systems available.
7. Maintenance cost of each type of tank or system.

With this information, tables may be prepared showing the total cost per year for each of the various types of tanks available. The cost can be reduced to a factor of cents per barrel of effective storage per year. This factor is usually the deciding one for selection. Other factors, however, that may have a bearing on selection are:

1. Fire safe features.
2. Fire hazards of the system.
3. Protection against corrosion.
4. Simplicity of operation.

● **Solution.** Let us assume a set of conditions for a typical terminal and determine the annual cost per barrel of storage for various types of tanks, based on a 20-year amortization. This typical pipeline terminal has a large throughput and comparatively small amount of storage volume. There may be some cases where these conditions are not true and the conditions are reversed, but the same type of analysis can be made for that type of station also. The assumed conditions are as follows:

Location—Midwest United States where average shade temperature is 62 F. This is also approximately the same as the average stored liquid temperature.

Product and storage required:

Premium grade	50,000 bbl.
Standard grade	75,000 bbl.
Third grade	50,000 bbl.

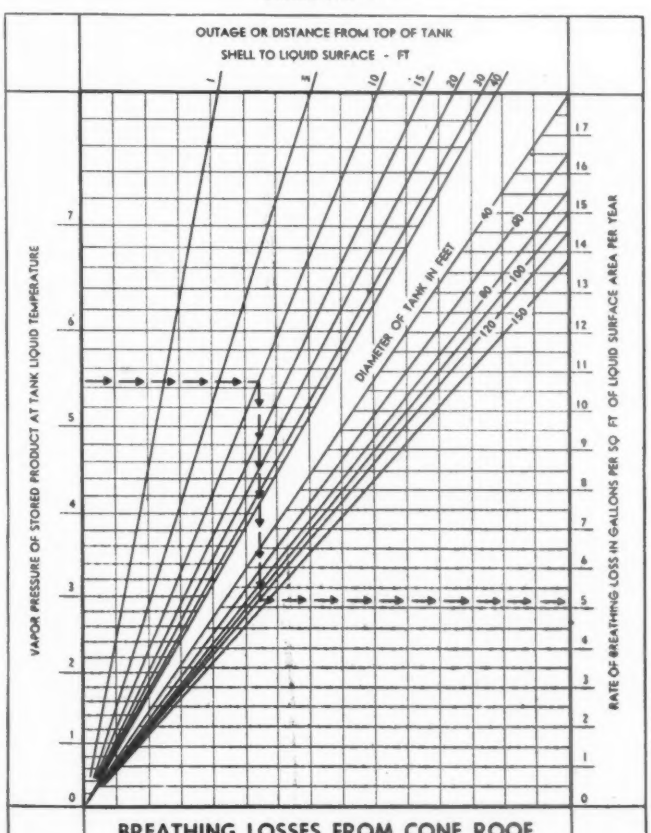
Annual throughput:

Premium grade	750,000 bbl.
Standard grade	1,500,000 bbl.
Third grade	500,000 bbl.

Tank capacities: In order to have sufficient net operating capacity, we selected one 54,000-bbl tank for the premium gasoline, one 80,000-bbl tank for the standard brand, and one 54,000-bbl tank for the third grade.

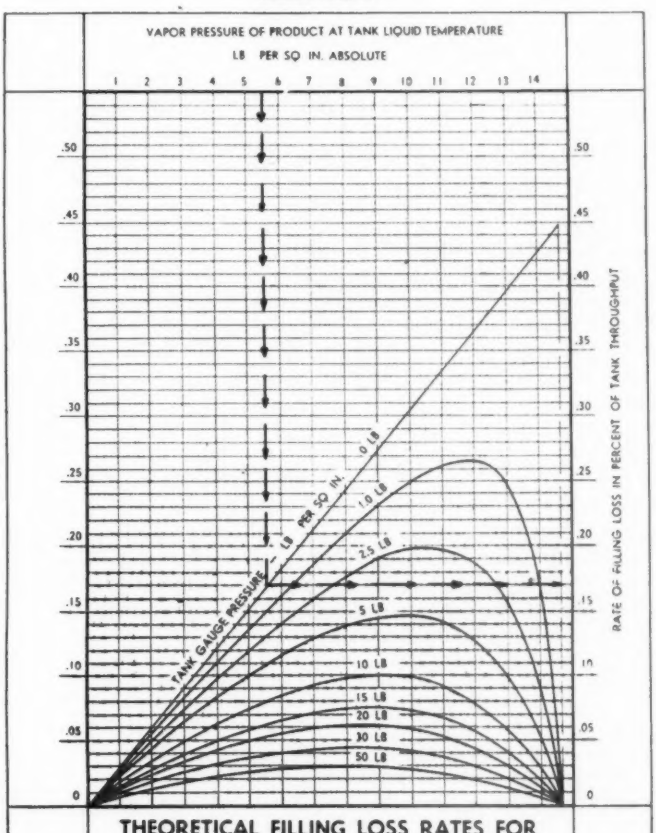
Tank dimensions: The 54,000-bbl

Chart No. 1

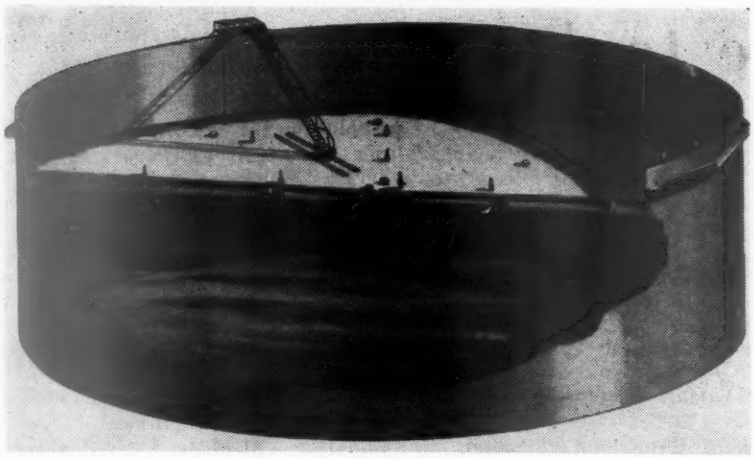

OUTAGE OR DISTANCE FROM TOP OF TANK
SHELL TO LIQUID SURFACE - FT
VAPOR PRESSURE OF STORED PRODUCT AT TANK LIQUID TEMPERATURE
DIAMETER OF TANK IN FEET
RATE OF BREATHING LOSS IN GALLONS PER SQ FT OF LIQUID SURFACE AREA PER YEAR

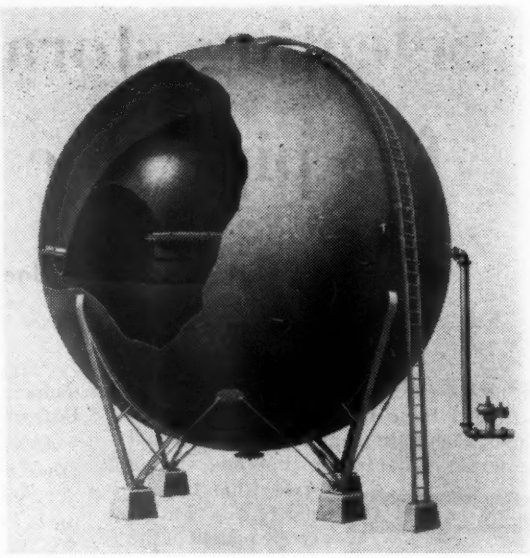
BREATHING LOSSES FROM CONE ROOF TANKS WITH CONSERVATION VENTS

Chart No. 2


VAPOR PRESSURE OF PRODUCT AT TANK LIQUID TEMPERATURE
LB PER SQ IN. ABSOLUTE
TANK GAUGE PRESSURE
LB PER SQ IN.
RATE OF FILLING LOSS IN PERCENT OF TANK THROUGHPUT

THEORETICAL FILLING LOSS RATES FOR STORAGE TANKS AND PRESSURE VESSELS





Horton double deck floating roof, above, and vaporsphere at right. (See below.)

tanks are 90 ft diam by 48 ft high and the 80,000-bbl tank 110 ft diam by 48 ft high. These dimensions are chosen since 48 ft of oil may be supported on most soils without a concrete foundation and the smaller the tank diameter, the less evaporation loss, regardless of tank type.

As fuel oil and kerosine lose so little by evaporation, cone roofs are most economical for their use and need not be considered in the study.

The systems available are:

1. Fixed volume tanks at atmospheric pressure. This would consist of the standard cone roofed type tank with half-ounce pressure vents.

2. A variable vapor space system. This can be either a system composed of two cone roofed tanks and one tank equipped with a lifter roof with their vapor spaces interconnected, or three cone roofed tanks connected by their vapor spaces to a Horton vaporsphere.

3. A fixed volume system capable of withstanding a maximum internal pressure caused by temperature variations. This system would be made up of Hortonspheroids designed for 2½ psi pressure.

4. Variable volume system, which is made up of individual floating roofed tanks.

● **Cost factors.** The cost factors entering the study are:

1. Initial investment.
2. Annual evaporation loss (usually the largest of all costs).
3. Maintenance.
4. Interest on the investment.

Taking these in order, the cost of the systems, excluding grades, is as follows:

1. Cone roofed tanks—two 54,000-bbl capacity and one 80,000-bbl capacity—total cost $119,000.

2. (a) Lifter roofed system—two 54,000-bbl cone roofed tanks plus one 80,000-bbl lifter roofed tank having an 8 ft lift plus vapor lines—total cost $143,000. (b) Vaporsphere system—two 54,000-bbl cone roofed tanks, one 80,000-bbl cone roofed tank, and one 75,000 cu ft vaporsphere plus the vapor lines—total cost $144,000.

3. Two and one-half psi wp Hortonspheroids—two 55,000-bbl capacity plus one 80,000-bbl capacity—total cost $213,000.

4. All three tanks equipped with double deck floating roofs—two 54,000-bbl capacity and one 80,000-bbl capacity—total cost $153,000.

In arriving at the vapor capacity required for the systems, (2, a and b), the average vapor pressure of 10 psi is used at an average liquid temperature of 62 F. The thermal expansion for the average daily temperature range of 30 F, plus about 25 per cent vapor pressure breathe, amounts to approximately 7½ per cent of the entire cubic capacity of the tanks when nearly empty. This figure is approximately 75,000 cu ft of vapor space required for expansion purposes.

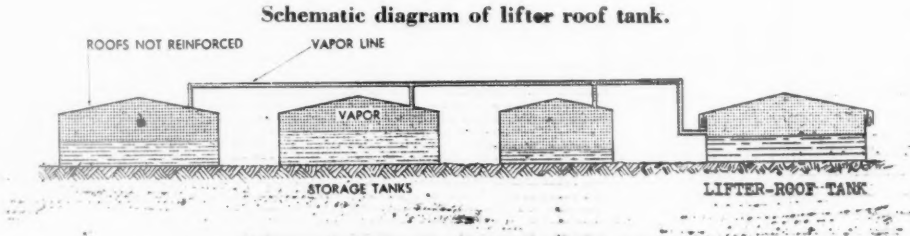
● **Evaporation loss.** Chart 1 shows the average of 157 standing storage tests made on cone roofed tanks equipped with pressure vents, the tests having been made during the last 15 years. The loss is expressed in gallons per square foot per year of tank cross-sectional area and is a factor of the vapor pressure at the stored tank temperature and the amount of outage. From this chart the standing storage losses for cone roofed tanks may be taken, with the assurance that the average data are conservative and as nearly correct as can be determined from the number of tests mentioned.

Chart 2 is a theoretical chart showing the pumping loss in fixed roofed tanks. Here again, the loss is a function of the vapor pressure at the stored tank temperature and the pressure effected by the container. The straight line curve represents the loss in per cent of throughput for atmospheric pressure on cone roofed tanks. These data are substantiated by tests that have been made by many major companies during this same period and the average is slightly higher than that given by the theoretical curve. The conclusion, therefore, is that this theoretical information is conservative and represents a true picture of the filling losses. It is based on saturation of the air vapor space above the liquid, which condition prevails unless the contents are moved in and out of the tank very rapidly, thereby preventing such saturation. Usually the motion is sufficiently slow so that saturation does occur.

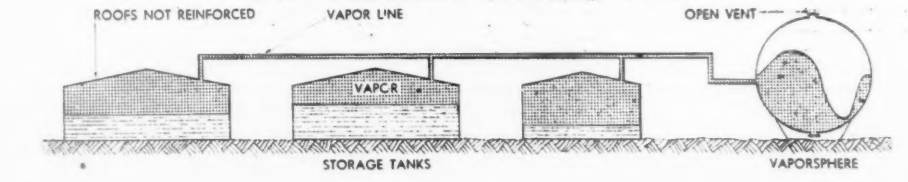
Evaporation losses by system.

1. Cone roofed tanks lose all vapors

Schematic diagram of lifter roof tank.



Schematic diagram of vaporsphere system.



due to thermal expansion of vapor space plus the displacement loss due to pumping.

2. Lifter or vaporsphere system suffers no loss due to thermal breathe provided all connections are 100 per cent perfect. These systems lose most of the displacement loss due to pumping in and out. As the vapor spaces are interconnected, it is possible to transfer some vapor from one tank to another during part of the period of operation. As a rule this percentage is small and in this type of system, with only three tanks, we have allowed a saving of 20 per cent of the loss suffered by a cone roofed tank or, in other words, the loss due to displacement in the vaporsphere system is 80 per cent of that for cone roofed tanks. Should the system contain more tanks and the relative throughput be small, then this loss could be less.

3. Spheroids of 2½ psi pressure lose nothing by thermal breathing. They save about 87 per cent of the working loss suffered by cone roofed tanks, as can be determined from Chart 2.

4. Floating roofed tanks have no pumping loss, for the surface of the gasoline is never exposed to the air as long as the roofs are kept floating, which they should be during all operations. Because of its tight seal, the double deck floating roof has an estimated efficiency of 90 per cent in stopping all breathing loss; hence the breathing loss for this type floating roof is estimated at 10 per cent of that of the cone roofed tanks.

● **Estimating the evaporation loss in barrels per year.** From a vapor pressure chart it will be seen that the average vapor pressure of liquid having a Reid vapor pressure of 10 psi at 100 F at a liquid surface temperature of 62 F is approximately 5½ psia. From Chart 1 the average breathing loss on cone roofed tanks with 10 ft outage equals 5½ gal per sq ft per year. From Chart 2 the working loss on cone roofed tanks is 17/100 of 1 per cent of the throughput. With these values and the efficiencies listed above, we arrive at the total of losses and their value shown in Tables 1 and 2.

TABLE 1. Volume of evaporation loss in barrels per year.

Type of system	Breathing	Working	Total	Value, in dollars at $3 per bbl
Cone roofed tanks	2,900	4,700	7,600	$22,800
Lifter or vaporsphere system	0	3,560	3,560	10,680
Spheroids (2½ psi)	0	4,150	4,150	12,450
Floating roofed tanks	290	0	290	870

TABLE 2. Annual cost per barrel of storage—20-year amortization.

	Cone roofs	Lifter system	Vaporsphere system	Spheroids (2½ psi)	Floating roofs
Initial investment/20	$ 5,950	7,150	7,200	10,650	7,650
Evaporation loss	24,600	10,680	10,680	12,450	1,050
Maintenance	300	600	800	300	600
Interest on investment	2,400	2,850	2,900	4,250	3,050
Total dollars	$33,250	21,280	21,580	27,680	12,350
Net operating capacity, bbl*	181,000	181,000	181,000	190,000	168,000
Cost, cents per bbl	18.4	11.8	11.9	14.5	7.4

*Net operating capacity is that volume above inlet and below 6 in. from top of shell for cone and lifters, floating range for floating roofs, and rated capacity for spheroids.

● **Conclusions.** From Table 2, it will be noted that the floating roofed tanks are the better investment economically, costing only 7.4 cents per bbl per year against 11.8 cents per bbl for the lifter system, and 18.4 cents per bbl for the cone roofed tanks.

The floating roofed tanks cost 4.4 cents per bbl per year less than the lifter system, showing approximately $8900 per year greater income on an additional investment of approximately $10,000, or 89 per cent per year return on the additional investment. Floating roofs of the Horton double deck type have the following additional advantages over any of the other systems mentioned:

1. By eliminating all vapor space, they prevent evaporation before it begins.

2. They form a permanent steel blanket over the surface of the gasoline and with a higher efficient seal, closing the space between the shell of the tank and the steel float, make a tank fire-safe.

3. Floating roofed tanks take the lowest insurance rating and are approved by the National Board of Fire Underwriters and fire marshals of most states. In many states and cities closer spacing, hence less ground space, is permitted with floating roofed tanks.

4. Each tank equipped with a floating roof is an independent operating unit; its service can be changed at will.

5. The product stored therein is not subject to contamination by vapor of any interconnected tanks.

6. Air is kept away from the product and gasoline is not subject to discoloration or gum formation, for no oxygen is in contact with the product.

7. By maintaining contact at all times between the roof and the product, corrosion is retarded even when handling sour products. On a cone roofed tank handling sour oils, the formation of hydrogen sulphide on the underside of the fixed roof produces scales that drop to the tank bottom and accelerate corrosion of the bottom plates as well. The floating roof eliminates this hazard.

Fortunately, in most sections of the United States floating roofed tanks operate without any difficulty due to weather conditions. In the Northwest, where extremely heavy snows are encountered, snow loads may become a factor and closed systems be more desirable because of these conditions; however, the buoyancy of the double deck roof will support a tremendous snow load without interfering with its operation.

The weight of snow load must be calculated to obtain accurate gauging. Water can be kept out of the lines by proper operation of the tank drain and water drawoff.

Finally, it appears that economically the floating roof is best suited for pipeline tanks and that the fire-safeness and independent operation add to its desirability for most pipe-line installations.

It is possible, under a condition of extremely large storage volume and comparatively small throughput per tank, that the closed system would prove more economical. The same analysis can be made for this type of installation as that given above, using proper values for the proposed operating conditions; hence this method can be applied to any storage problem with reasonable accuracy and sound resultant selection. ★★★

New synthetics insure products

Technologic developments in use of natural gas for purposes other than for direct fuel and energy have uncovered an important potential raw material source for hundreds of synthetic products, the Bureau of Mines reported recently. Some better known materials or raw material stock were derived from natural gas during wartime including synthetic rubber, plastics as substitutes for rubber and silk, ammonia, glycerine, toluene and nitroparaffins for use in explosives and additives for motor fuels.

Industry research continues to provide scientific insurance against reduction or exhaustion of crude oil supply in the future. Great progress in methods for making liquid fuels from coal or gas just as are made from oil today continues to be made. The techniques of gasification of coal at Pittsburgh, Pennsylvania and Gorgas, Alabama, recently announced, are being carefully studied, and oil shale development at Rifle, Colorado, will add further knowledge to this important field. Stanolind Oil and Gas Company has announced that gasoline from natural gas will be on a commercial scale in 1949.

GREAT GUNS

REVERE ARSENICAL ADMIRALT CONDENSER TUBES..

hold these disting advantages:

PRACTICALLY 100% R SISTANT TO "DEZINCI CATION" ATTACK.

EXCEPTIONAL "ROLLING-IN QUALITY.

Therefore, you can reasonably expect great service and economy on heat transfer equi ment fitted with Revere tubes—great guns f bringing down refinery operation costs.

As a further aid to men interested in efficie heat transfer, Revere maintains a Technic Advisory Service. This group of practic men—using their abundance of knowled and field experience—can be of help to y in solving difficult tube and plate problem

Call on them thru your nearest Jones & Laug lin Supply store—just as you do for reliab advice on choosing equipment to do any field job.

Stocks of copper, brass and steel tubes are maintained at our Tulsa and Houston stores. Each has excellent facilities for cutting and burring.

Export Sales Office: 230 Park Avenue, New York 17, New Yor

JONES & LAUGHLIN SUPPLY COMPANY

Subsidiary of Jones & Laughlin Steel Corporation

J&L STEEL

TULSA, OKLAHOMA

P 306.214.

Dr. F. Morgan, one of the Gulf men responsible for the oil field x-ray, is adjusting a rock sample in the machine. The secretary will record the findings. Purpose of the device is a greater percentage of oil recovery.

X-ray oil field — from laboratory

A METHOD of x-raying the oil fields by remote operation from its research laboratories, has been developed by Gulf Oil Corporation. It will soon be put to use to increase the yield of the world's petroleum reservoirs.

The new development helps solve the riddle of how oil flows through the sand and rocks under any particular field, and how it is affected by underground water and gas. Answers gained by x-ray to such problems will make possible more productive recovery.

The x-ray technique will disclose the amount of oil that a particular well can recover—a valuable factor in planning use of petroleum reserves. It is also expected to make possible reopening and additional recovery of oil from abandoned wells.

As x-raying entire oil fields at their sites would be impractical, developers of the new method took the opposite course and brought the fields to the laboratory. Experiments were begun with columns of sand 10 ft high taken from the oil wells.

Today a small 3-in. by 1-in. sample, or core, from the drill hole is used. In effect, the core is made to reproduce in miniature the layer of rock or sand from which it was taken. Reactions studied within its 3 in. give a picture of flow conditions in a stratum perhaps hundreds of feet thick and miles in extent.

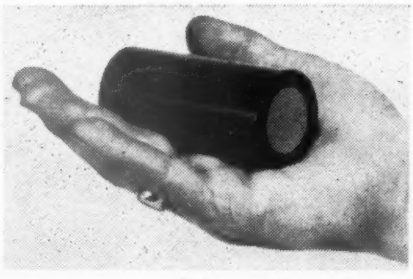
To make such studies, the core is subjected to artificial pressures and saturations of oil, gas, and water. The progress of these elements in the core is gauged by an x-ray device technically named Apparatus for Determining Permeability-Saturation.

The x-ray beams follow the reaction by means of an opaque tracer mixed with the liquid or gas. Variations in intensity of the beams, as they pierce the core, are caused by the tracer, indicating the extent of saturation. The principle is similar to taking x-rays of organs of the human body filled with opaque barium.

First step of the researcher is to establish a basis for comparison by studies of the core at 100 per cent and at zero saturation. Then an extensive series of flow experiments, reproducing conditions that might be created by various recovery methods, must be run through.

Effects of gravity, capillary attraction, and the amounts of oil, gas, and water already in the sand are charted. These procedures must be repeated on sometimes as many as 10 or 11 cores taken from the different layers through which the well extends.

Rock sample, cast in bakelite, can be made to reproduce in miniature the behavior of oil, water, and gas in the stratum from which it was taken.



From correlation of such data, the laboratory can determine how natural pressure, or artificial gas injection, or water flooding will move oil through various strata of the field being studied toward well shafts. Operating methods can be planned accordingly to assure the greatest yield, and the extent of the yield can be forecast.

For example, permeability-saturation studies are useful in indicating whether injected gas can move oil through the strata at varying degrees of water saturation. The method also aids the operator in minimizing the escape of injected gas through non-productive formations.

Besides new fields, the x-ray technique will explore the possibilities for salvaging more oil from abandoned wells. It will give for the first time an accurate picture of the flow conditions in abandoned fields, from which practical methods for additional recovery can be developed.

Permeability-saturation determination by x-ray represents an extension of the electrolytic model oil field technique developed by the same research organization for predicting generalized oil field behavior and guiding placement of wells.

The new method, however, carries further the earlier process by analyzing localized flow conditions, both existing and possible, in specific fields. ★ ★ ★

This Combination

This complete rig is the lowest in cost, the highest in quality, longest in life, fastest in drilling speed and lowest in moving expense of any comparable rig in the world. ***Ask any owner for proof of these statements.***

Moving and rigging up of both the "Cardwell" draw works and mast are simple and fast. Streamlined single or twin-engine draw works leaves plenty of floor space for the crew. Lee C. Moore Jackknife masts are available with all "Cardwell" draw works, combination rotary and cable tool drilling rigs, and deep well servicing hoists.

Model S single engine draw works with Lee C. Moore mast

Hydrocarbon absorption and fractionation process design methods

Part 2. Basic Definitions and Concepts

By WAYNE C. EDMISTER*,
Hydrocarbon Research, Inc.

EXCLUSIVE

THE separation of hydrocarbons by absorption-stripping and fractional distillation involves several basic operations taking place simultaneously, namely: fluid flow, heat transfer, diffusion, vaporization and condensation. These operations will be called "unit operations," while absorption-stripping and fractional distillation will be called "separation processes." The term "absorption" will be used for convenience to identify a continuously operating absorption-stripping system consisting of an absorber, a rich oil stripping still and the necessary auxiliaries. Likewise, "fractionation" applies to a continuously operating fractional distillation system consisting of a fractionating column of bubble plate enriching and stripping sections plus the necessary auxiliaries. "Rectification" and "fractionation" are different words for the same process, i.e. continuous fractional distillation with multistage vaporization and condensation.

Absorption and fractionation equipment is designed, built, and operated by a combination of theory and practice, both of which are dependent upon the other so that fundamental data and theoretical methods are required to get the empirical design factors that come from analyzing performance data while the plant performance factors are necessary to perfect the theoretical calculation methods. Both the theoretical and empirical design tools are used in absorption and fractionation process design, which involves all four of the fundamental concepts of process engineering, namely: (1) material balance (conservation of matter), (2) heat balance (conservation of energy or first law of thermodynamics), (3) equilibrium (based on second law of thermodynamics), and (4) rate of material and heat transfer. This general approach to the process design of hydrocarbon separation processes is the conventional chemical engineering technique.

The first article of this series presented a summary discussion of the fundamentals and process design procedure for hydrocarbon absorption and fractionation. Also the processes were described in a general way as an introduction to the technical treatment to follow. This, the second article of the series, will be devoted exclusively to the basic definitions and concepts of vapor-liquid separation processes that are prerequisite to the development of charts and equations for the design of absorption and fractionation equipment. In addition to the basic laws applying to these separations, various terms will be defined and some attention given to the mathematical methods used.

*Home address, 7 Gilmore Court, Scarsdale, New York.

DEFINITIONS

Following are definitions of terms used in this treatment of absorption and fractionation:

"Wet gas" is the gas containing "condensibles" for recovery that is charged to an absorber. "Residue gas" is the offgas leaving an absorber after the condensibles are removed.

"Lean oil" is the stripped and denuded solvent leaving the bottom of the stripping still and going to the top of the absorber.

"Rich oil" is the solvent plus the recovered components leaving the bottom of the absorber and going to the top of the stripping still.

"Reflux" applies to liquid pumpback to the top of a fractionator and also the liquid "downflow," the difference in quantities being due to differences in heat contents through differences in temperatures.

"Induced reflux" is formed at intermediate trays between the top and the feed tray through the mechanism of condensing on each tray.

"Reflux ratio" (L/V) is the ratio of liquid downflow to vapor upflow in the enriching section of a fractionator. "Reflux ratio" is sometimes used to denote ratio of pumpback to net distillate product. Internal ratios must be molal for use in calculations.

"Reboiled vapors" are produced by the heat supplied in the reboiler. These vapors carry heat up the column, stage-to-stage, through the mechanism of reboiling on each tray.

"Boilup ratio" (V/L) is the ratio of vapor upflow to liquid downflow in the stripping section of a fractionator.

"Equilibrium" refers to a state of rest in the distribution of components between liquid and vapor phases in contact at the same temperature and pressure conditions. The two phases are referred to as "equilibrium vapor" and "equilibrium liquid." A system not at equilibrium is moving in that direction. Thermodynamics is used to estimate equilibrium but will not predict the rate of approach to equilibrium.

The "rate of approach" to phase equilibrium by interphase transfer of components from liquid to vapor and vice versa would be expressed in terms of diffusional resistances and driving forces if there were sufficient fundamental data and a convenient method of handling the mathematics. As a substitute for this rigorous treatment of the approach to equilibrium, plate efficiencies are used.

"Plate efficiencies" are expressed as: (a) the ratio of actual change in composition of vapor or liquid in going through a stage or plate to the change that would have occurred had the vapor or liquid been in equilibrium with the opposite phase on the plate, or (b) the ratio of the number of theoretical plates or stages to the actual number required to accomplish the given separation. The first is the "local" plate efficiency, which is expressed in terms of liquid or vapor compositions depending upon which is controlling. The second is the "overall" plate efficiency.

"Material balance" is the numerical application of the law of conservation of matter, or putting it another way, "what goes in must come out." Material balances are usually written for individual components as well as for total streams. Component material balances are involved in all absorption and fractionation calculations.

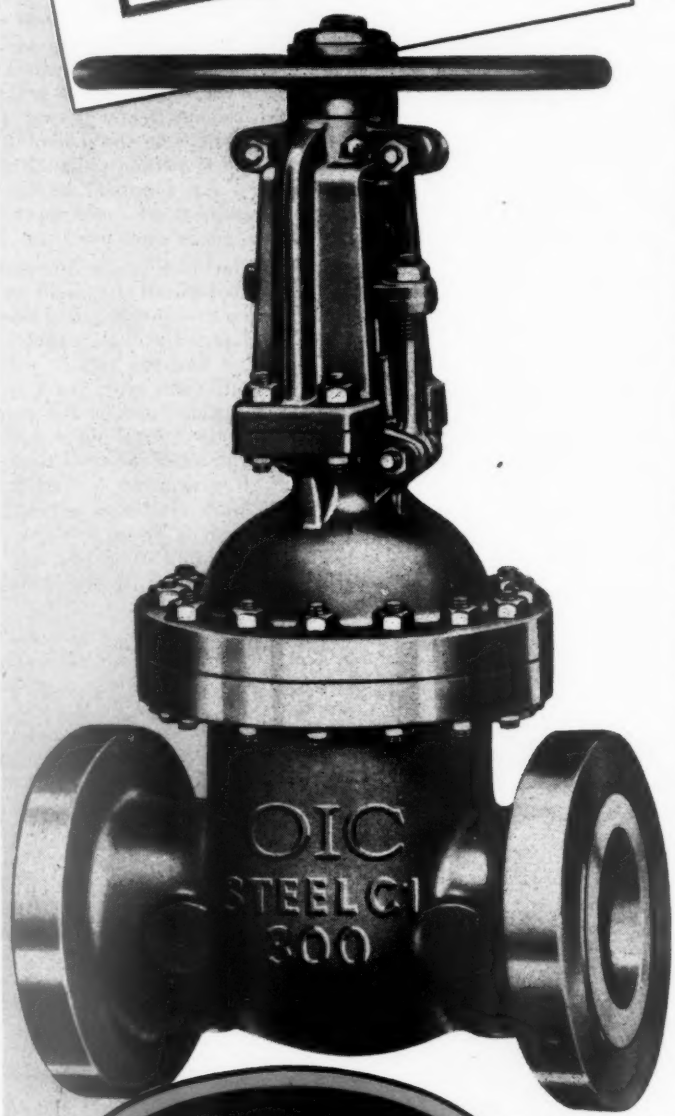
"Heat balance" is the numerical application of the law of conservation of energy, or the first law of thermodynamics. Heat balances are made around sections of the apparatus as well as the entire column to determine relative vapor and liquid quantities and duties of reboilers, preheaters, condensers, etc. For most hydrocarbon absorption and fractionation calculations, heat balances do not enter into the detailed theoretical plate and component calculations except to determine vapor and liquid quantities.

"Bubble plates" consisting of vapor risers, bubble caps, overflow weir and downspout are usually used as the vapor-liquid contacting device in hydrocarbon absorption and fractionation although perforated trays and packing are sometimes used.

"Minimum plates" are the number of theoretical equilibrium stages required for a given separation at total reflux, i.e. returning all overhead as reflux and taking no net distillate product. At total reflux with minimum plates, the pumpback reflux ratio is infinite and the capacity of a column is zero. In other

PACE-SETTER IN VALVES

Appoints
AS A NEW D



NO WONDER OIC SETS THE PACE IN VALVES

OIC offers a line of Steel, Iron and Bronze valves that are tops in engineering. Progressive OIC engineers have incorporated many important extra-value features into their advanced design.

For example, all OIC steel valves rated at 300 lbs. and above have pressure parts cast from carbon molybdenum steel! Body and bonnet walls, yoke arms and bolting are extra strong. Gate valves feature heavy I-beam wedges and barrel-type seat rings. Globes and angles have large port area and unobstructed flow at the diaphragm. Check valves provide clear-way flow. OIC stuffing boxes are extra-deep with a special condensing chamber below the packing. And the new, patented gland and gland-flange unit that facilitates repacking is exclusive with OIC.

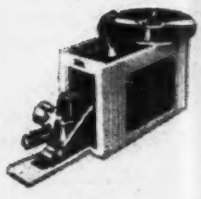
OIC

VALVES

STEEL • IRON • BRONZE

NEW 248-PAGE OIC CATALOG giving complete information on steel, iron and bronze valves and their application is available to you now. Write for your copy to The Ohio Injector Co., Wadsworth, Ohio.

SEE THE NEW FILM—For latest information on steel valves, see the new OIC sound slidefilm. Write today to The Ohio Injector Company, Wadsworth, Ohio, for a showing right in your place of business.



BETHLEHEM SUPPLY

DISTRIBUTOR

GHQ FOR REFINERY SUPPLIES

GOOD NEWS SPREADS FAST

And, it is welcome news to oil people in the Mid-continent and Southwestern refinery centers and oil fields that OIC valves are now readily available to them at the 47 stores and offices of Bethlehem Supply.

Nobody knows better than an oil man — millions of dollars can flow through a valve. Nowhere else on earth are requirements any more exacting, performances any more carefully watched than in the field of liquid gold.

Yes, it's good news to oil men that Bethlehem, GHQ for refinery supplies with its service and engineering facilities, now puts OIC valves at their finger tips.

Stores and Offices of The Bethlehem Supply Company

GENERAL OFFICES: BETHLEHEM BUILDING, 21 EAST SECOND ST., TULSA, OKLA.

ARKANSAS
Magnolia
COLORADO
Craig
ILLINOIS
Grayville
Salem
KANSAS
Chase
El Dorado
Great Bend
Russell
*Wichita
LOUISIANA
Eunice
Harvey
Houma
Lake Charles
New Iberia
*New Orleans
Shreveport
MISSISSIPPI
Laurel
NEW MEXICO
Artesia
Hobbs
OKLAHOMA
Lindsay
Oklahoma City
*Ponca City
Seminole
*Tulsa
Wewoka
TEXAS
Alice
Beaumont
Borger
Bowie
Carthage
Corpus Christi
*Corsicana
*Dallas
*Fort Worth
Graham
Houston
Kermit
Kilgore
LaWard
McAllen
Odessa
Pampa
*San Antonio
Sundown
Wichita Falls
Winnsboro
WYOMING
Casper

*Office Only.

D-547-26

words, the reflux ratio defined as L/V is unity and the pumpback reflux ratio defined as L/D is infinite.

"Minimum reflux" is the quantity of reflux required for a given separation with an infinite number of plates, thus defining the lower reflux ratio limit the same way that "minimum plates" at total reflux defines the lower limit for the number of theoretical plates.

"Optimum reflux ratio" is the reflux ratio between "total reflux" and "minimum reflux" that gives the most economical design for the columns and auxiliaries. The "optimum" design is usually selected at the reflux ratio with which the equipment investment cost plus the operating charges for a given time period is a minimum.

NOMENCLATURE

The following nomenclature will be used in these articles:

stage = a theoretical contact zone where vapor and liquid leaving are in equilibrium,

plate = an actual vapor-liquid contact zone where interphase transfer of heat and components occur: approaching, equaling or even bettering equilibrium,

x = mol fraction of component in liquid phase,

y = mol fraction of component in vapor phase,

X = mols of component in liquid phase per mol of liquid entering absorber or stripper,

Y = mols of component in vapor phase per mol of vapor entering absorber or stripper,

l = mols of component in liquid phase,

v = mols of component in vapor phase,

f = mols of component in fractionator feed,

F = total mols of fractionator feed,

D = total mols of fractionator distillate product,

B = total mols of fractionator bottoms product,

L = total mols of liquid downflow,

V = total mols of vapor upflow,

d = mols of component in fractionator distillate,

b = mols of component in fractionator bottoms,

$K = y/x$ = phase equilibrium constant,

n = number of theoretical plates (numbered from top to bottom) in an absorber or in enriching sections of a fractionator,

m = number of theoretical plates (numbered from bottom to top) in a stripper or in stripping section of a fractionator,

A = absorption factor = L/KV,

S = stripping factor = KV/L,

E_a = absorption efficiency = $\dfrac{(Y_{n+1}-Y_1)}{Y_{n+1}}$,

E_s = stripping efficiency = $\dfrac{(X_{m+1}-X_1)}{X_{m+1}}$,

α = relative volatility or separation factor = K_{light}/K_{heavy},

ASTM = Identification of laboratory distillation for petroleum stock accepted by American Society for Testing Materials. Sometimes called "Engler,"

TBP = True boiling point, a laboratory distillation of petroleum fractions,

EFV = Equilibrium flash vaporization, representing continuous flow vaporizations which can be presented by curves on same scale with ASTM and TBP,

A_e, A_l, and A' = effective absorption factors,

S_e, S_l, and S' = effective stripping factors,

f_g = gradient correction to A_e and S_e for fractionation,

f_c = curvature correction to A_e and A_l (also S_e and S_l) for fractionation,

ϕ_1 (A) and ϕ_2 (A) = functions of A for enriching section of fractionator,

ϕ_1 (S) and ϕ_2 (S) = functions of S for stripping section of fractionator,

ρ_L and ρ_V = densities of liquid and vapor in lbs/cu ft at tower operating conditions,

h_w = weir depth,

h_o = head of liquid over weir,

h_{rc} = head lost by vapor through risers and caps,

h_{ds} = head lost by liquid through downspout and sealpot,

h_g = liquid gradient across tray,

W = actual weir length,

W' = effective weir length,

K_w = weir discharge coefficient.

Other terms will be introduced as required.

MATHEMATICS

The complicated operations of absorption and fractionation processes do not lend themselves to rigorous mathematical treatment. With the shortcuts and approximations that are necessary in making multicomponent hydrocarbon separation calculations, the mathematics involved is relatively simple. For practically all computations and most equation development, arithmetic and algebra are sufficient. Calculus and differential equations are encountered only in developing the thermodynamic tools, such as enthalpies and fugacities, required.

Thus, there are two extremes with hardly any compromise, as far as the mathematics of solving complex hydrocarbon separation process design problems is concerned. One extreme is the precise formulation, by partial differential equations, of the interphase transfer of heat and material for each component and each stage and solving these equations for the combined multistage process by the use of some suitable means such as electronic calculators, etc. This method would involve using diffusional resistances and driving forces in place of plate efficiencies. The equations would be formulated for the particular plate and vapor-liquid flow patterns involved. Variations in temperature and quantities of liquid and vapor from plate-to-plate, as determined by equilibrium and heat balance conditions, would be taken into consideration in this rigorous method. The deviations from perfect gas and from ideal solutions would likewise be included. Needless to say such a method is of academic interest only at the present time. However, it is worth while to recognize the limit of perfection to which separation computation methods may approach. It is safe to say that methods of solving the equations, as well as formulating them, are both bottle-necks in the development of such a rigorous method.

The other extreme is not as sharply defined because there can be a varying degree of simplification depending upon the shortcut assumptions made. The more simplifying assumption made, the easier the mathematics becomes. The most significant simplifying assumption is that of the equilibrium stage or theoretical plate concept. With this short cut alone, separation calculations become a series of equilibrium and material balance computations for each stage with heat balances at occasional points. These computations are made by successive approximations and are time-consuming in proportion to the number of components and the number of stages. Arithmetic is the only type of mathematics required for these plate-to-plate computations.

By combining the basic equilibrium and material balance relationships and making the proper mathematical manipulations, more direct calculation methods are obtained. This can be done in different ways, as will be shown later in this series. The mathematics used in developing these equations is algebra, the most complex step being to find condensed solutions of series equations.

Many design methods include graphs, which are developed from theoretical equations plus calculation results and performance data. Other design methods include the construction of plots and/or graphical stepwise computations. It is obvious that the mathematics used in hydrocarbon absorption and fractionation process design is of the "engineering" variety and not the "higher math" required in thermodynamics.

INTERPHASE TRANSFER MECHANISMS

As pointed out in Part I of this series, hydrocarbon absorption and fractionation processes function through a concentration difference between enriched and depleted streams and the multiplication of this by counter-current contacting of the vapor and liquid. This interphase transfer of material takes place by a diffusion and/or vaporization-condensation. Both mechanisms occur in fractionation but diffusion is the mechanism of absorption.

Quantitative computations of the diffusional and vaporizational effects are seldom made for absorption and fractionation processes. It is customary to cover the total transfer by means of the theoretical equilibrium plate concept and plate efficiency. However, it is well worthwhile to understand these two mechanisms. For this discussion, it is

Wherever you go – whatever you do
You use products made better with BECKMAN pH CONTROL!

Did You Know These Beckman pH Facts?

...that Beckman pioneered modern glass electrode pH equipment, transforming the cumbersome laboratory apparatus formerly used into a compact, practical, portable instrument that paved the way for today's simplified pH measurement and control?

...that the first completely automatic glass electrode pH indicator, recorder and controller was pioneered by Beckman? Operating entirely without batteries, this instrument made automatic process control accurate, convenient, practical—and is today widely used in all parts of the world.

...that Beckman pioneered the High Temperature Glass Electrode system which, for the first time, enabled continuous pH measurements to be made at temperatures up to 212°F (100°C)? This electrode system is of tremendous value wherever hot process fluids must be controlled.

...that the High pH Glass Electrode system is also a Beckman development? This unique glass electrode unit can be used to measure high pH values even in the presence of sodium ions... and extends the usefulness and accuracy of glass electrode equipment to many industries where alkaline solutions in combination with sodium ions have heretofore presented difficulties.

...that the above are only a few of many developments that make Beckman pH Equipment the most advanced, the most accurate, the most adaptable in the field of pH?

The tires you ride on are made with the aid of Beckman pH Control. It was found that coagulation of the synthetic rubber is very sensitive to variations in the pH (acidity or alkalinity) of the processing solutions. Therefore, Beckman Automatic pH Equipment is used to control these processes for efficiency and economy.

The motion pictures you see are processed with the aid of Beckman pH Control. The developing laboratories of the major motion picture studios discovered that Beckman pH Equipment gives better control of the quality and uniformity of the film developing processes, insures clearer prints, less waste and better projection qualities.

The water you drink is probably Beckman pH Controlled. In more and more municipal water systems, purification of the drinking water is being regulated with the aid of Beckman pH Equipment, thus insuring a water supply that is both pure and uniform—plus important savings in treating costs.

The food you eat is another item that, today, is made better and more uniform with the aid of Beckman pH Control. It has been found that virtually all types of food processes—from baking crackers to canning meats—are performed more efficiently, more economically with the aid of Beckman pH Equipment.

Are YOU Using This Cost-Cutting Tool in Your Plant?

ONLY A FEW YEARS AGO pH control was more of a laboratory curiosity than a cost-cutting industrial tool. But today—largely through the far-reaching developments of the Beckman research staff—modern pH control has become an indispensable tool for speeding chemical processes, safeguarding quality, reducing waste and simplifying production operations throughout industry. *In fact, wherever there's water there's pH...and wherever water or water processes are used, chances are the job can be done quicker, better, at lower cost with Beckman pH Control.*

How About Your Product?

The above are but a few of the innumerable ways alert industries are cutting costs, improving product quality, reducing waste and making other vital savings with Beckman pHControl. Have you investigated the vital savings it can make in *your* operations? Our engineers will gladly study *your* pH problem and suggest ways that Beckman pH Control can save money for you. *Beckman Instruments, National Technical Laboratories, South Pasadena 26, California.*

FREE...

"What Every Executive Should Know About pH"

Helpful, informative, non-technical. Send for your copy.

BECKMAN INSTRUMENTS CONTROL MODERN INDUSTRIES

convenient to visualize diffusion and vaporization as separate mechanisms although they often occur simultaneously.

When the vapor and liquid coming into contact are near the same temperature and far removed from phase equilibrium, as is the case in the absorption of condensibles from wet hydrocarbon gas by a lean oil solvent, the diffusion is the mechanism of transfer of the condensibles from the gas into the oil. Here the picture is not confused by the presence of condensation or vaporization, as is the case in fractional distillation.

In a fractionator the liquid from the tray above is mixed with the vapor from the tray below and the mixture separated into new vapor and liquid streams leaving the separator, which may or may not be in equilibrium with each other, depending upon the fluid properties and the rate. If the mixing is thorough enough and the contact time long enough, the resulting vapor and liquid will reach equilibrium. Or if the diffusional resistance is very low, equilibrium will be reached in shorter times.

For the present, it may be assumed that the liquid and vapor phases involved will be brought together in some manner and maintained in contact for a period through the mixing and unmixing actions. The interface or surface of contact between two separate phases is not fixed but is in motion. Because of free or forced convection currents the main body of each fluid is invariably in motion with respect to the interface, resulting in a fluid film adjoining the interface in each fluid.

The transfer of material from one phase to another may be broken down into the following steps: (a) transfer through the main body of one phase, (b) transfer through the film of this first phase to the interface between the two phases, (c) transfer across the interface, (d) transfer through the film of the second phase, and (e) transfer through the main body of the second phase. The driving force for such a transfer is the concentration difference and the resistance to the transfer is the reciprocal of the diffusivity. The principal resistance to interphase diffusion is the double film at the interface.

It is a common observation that separate phases brought into contact tend to approach a state of equilibrium. All available data indicates that phases in contact are always at equilibrium at the actual interface, or substantially so. It is usually assumed that a condition of equilibrium exists at the interface. This is equivalent to saying that the rate of interaction or component transfer between the phases at the exact point of contact is so rapid that this interaction is not a controlling factor in determining the net rate of transfer. The rates of transfer in the films and main bodies of the phases themselves are the controlling factors. For some separation processes, such as absorption, extraction, and stripping the rate of mass transfer in the phases is almost as important as the equilibrium itself. For others, such as distillation, diffusion plays a relatively unimportant role.

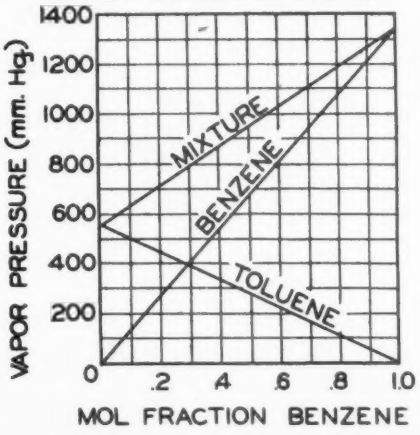
There are two types of diffusion: (a) steady state molecular diffusion, and (b) turbulent or eddy diffusion. The distinction between these types of diffusion is obvious. Strictly speaking, true diffusion takes place only when the transfer of material from one phase to another is accomplished without the aid of turbulence. Eddy diffusion involves the transfer of material from one phase to another by: (a) mixing caused by convection currents set up by temperature differences or, (b) turbulence caused by flow agitation, as well as (c) molecular diffusion caused by concentration differences. Mass transfer through a phase involves eddy diffusion, while transfer across the film is usually by molecular diffusion.

The study of petroleum refining separation processes is concerned with diffusion in gases and in liquids. Gaseous diffusion is more rapid at high temperatures because of greater molecular velocities and more rapid at low pressures because the distances between the molecules are greater and the collisions less frequent. Diffusion takes place much more slowly in liquids than in gases, because of the greater resistances to diffusion caused by the greater density of the liquid phase.

In the case of absorption of one or more components from a gaseous mixture, there are two diffusional processes that take place in series. The gases being absorbed must first diffuse from the gas through the gas film, which is made up largely of the unabsorbed gases, and second they must diffuse through the liquid film and into the main body of liquid.

The diffusion occurring in fractional distillation differs from that in absorption in that there are two diffusional processes going on in counter-current directions at the same time and there is no relatively inert material present. Distillation involves the simultaneous diffusion from liquid to vapor of the components in both phases. Two films are formed, not of a stationary or an inert material, but of active components passing counter-current to each other, which means that the rate of diffusion in one direction is affected by the rate in the other direction.

FIG. 6. Partial pressure composition diagram for benzene-toluene. Mixture at 100 F.



Theory and equations have been developed for the diffusion of gases as a part of the development of the kinetic theory of gases. The kinetic theory of liquids has not been as highly developed as the kinetic theory of gases so that theoretical diffusion equations for liquids comparable with those for gases have not been developed. Because of this undeveloped situation regarding liquid diffusion the well developed theories for gaseous diffusion are not of much value where both liquid and gas are involved, which is the case in practically all petroleum refining separation processes.

For most petroleum processes, diffusion considerations are used only to assist in predicting the efficiency of the interface contact and approach to equilibrium, the remainder of the design being based on equilibria.

Separate phases brought into contact tend to approach a state of equilibrium by the interphase transfer of material. In the case of gas and liquid, the gas will diffuse into the liquid phase or become absorbed in it. An equation can be developed for diffusion into fluid flowing in viscous motion, but when the flow is turbulent, as it is in all petroleum absorbers, fractionators, etc., the motion of the oil and the equilibrium relations become extremely complicated and haphazard. Therefore, overall transfer coefficients must be used and the theoretical plate concept was invented to fill this gap. Liquid and vapor leaving a theoretical plate or stage are in equilibrium. The approach to this equilibrium condition in actual practice is measured by the so-called plate efficiencies, i.e. "local" and "overall" plate efficiencies.

Vaporization and condensation are "vapor pressure" or "molecule escape and capture" operations, which may occur separately or together. In vaporization the escaping tendency, expressed in terms of vapor pressures or fugacities, of the lighter components causes them to vaporize from the liquid. The reverse happens in condensation.

EQUILIBRIUM

The fundamental laws of phase equilibria and the development of fugacities and vapor-liquid distribution constants is a subject for thermodynamics. In this series, the use of the phase equilibria computation methods represents a major part of the process design procedures for absorption and fractionation, which makes the subject of equilibrium one of more than academic interest.

There are three types of mixtures: miscible, immiscible and constant boiling mixtures. Each requires a different technique. For miscible mixtures at vapor-liquid equilibrium conditions, two phases exist, i.e. one vapor phase and one liquid phase. For immiscible mixtures at vapor-liquid equilibria, there will be one vapor phase and two or more immiscible liquid phases. There are also partially immiscible mixtures where two liquids are only partially soluble in each other. Some compounds that have dif-

A complete line of quality petroleum products

GULF OIL CORPORATION
GULF REFINING COMPANY

General Offices, Pittsburgh 30, Pa

Refineries:

NEW YORK, N. Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
TOLEDO, O. · CINCINNATI, O.
PORT ARTHUR, TEX.
FORT WORTH, TEX.
SWEETWATER, TEX.

Sales Offices:

BOSTON · NEW YORK
PHILADELPHIA · PITTSBURGH
TOLEDO
LOUISVILLE · ATLANTA
NEW ORLEANS
HOUSTON

ferent volatility characteristics and are miscible in each other form constant boiling mixtures when blended in the proper concentrations.

Although hydrocarbon absorption and fractionation process design calculations are usually concerned with only miscible mixtures and not immiscible or constant boiling mixtures, a brief discussion of these other types of mixtures is in order for orientation purposes.

Miscible systems not forming constant boiling points. For an equilibrium system composed of miscible components and not forming a constant boiling point the vapor pressure of the liquid phase is equal to the sum of the partial pressures of the components. A simple example of such a mixture is the two component system benzene and toluene, the components of which are so similar that they form an ideal as well as a miscible solution. A partial-pressure vs. composition diagram for the components of this mixture at 100 F is given as Fig. 6. The vapor pressure composition relationship for this mixture is a straight line connecting the vapor pressures of each component. For some mixtures such is not the case, however. These exceptions will be discussed later.

A temperature-composition diagram will be developed for this mixture at atmospheric pressure, where this system obeys Raoult's and Dalton's laws and it is safe to use vapor pressures and the total pressure in computing phase equilibria constants. The vapor pressures and the resulting K constants at atmospheric pressure are given in the following tabulation:

	Vapor pressure Millimeters of mercury		Equilibrium phase distribution Constant K at 760 mm. hg.	
Temp. C	Benzene	Toluene	Benzene	Toluene
80.6	760	..	1.000	..
85.0	877	345	1.154	0.454
90.0	1016	405	1.335	0.533
95.0	1168	475	1.535	0.625
100.0	1344	557	1.769	0.733
105.0	1532	645	2.015	0.849
110.0	1748	743	2.300	0.977
110.7	..	760	..	1.000

At pressures high enough to invalidate Raoult's and Dalton's laws, fugacities should be used instead of vapor pressures and total pressure. At these conditions fugacities would give the same results obtained above. Using these K constants it is possible to compute the composition of the equilibrium vapor and liquid at any temperature between the boiling point of benzene (80.6 C) and the boiling point of toluene (110.7 C) by the equations developed below.

Let x_B = mol fraction of benzene in liquid phase,

x_T = mol fraction of toluene in liquid phase,

y_B = mol fraction of benzene in vapor phase,

y_T = mol fraction of toluene in vapor phase,

$K_B = \frac{y_B}{x_B}$ = equilibrium constant for benzene,

$K_T = \frac{y_T}{x_T}$ = equilibrium constant for toluene.

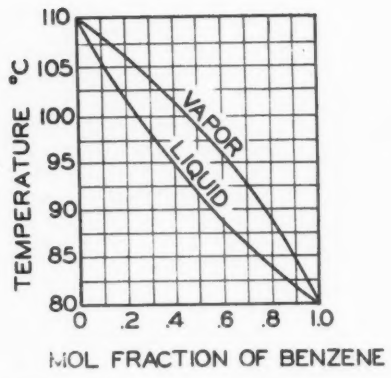


FIG. 7. Temperature-composition diagram for benzene-toluene system at 760 mm Hg pressure.

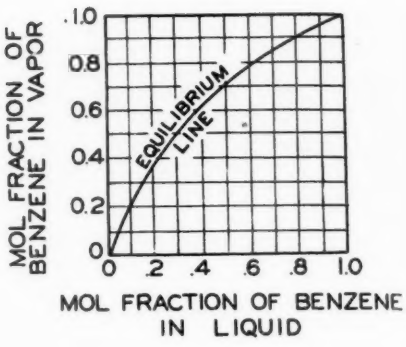


FIG. 8. Equilibrium diagram for benzene-toluene system at 760 mm Hg pressure.

The following expressions may be written for the system from these definitions of terms.

$$x_T = 1 - x_B \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$y_T = 1 - y_B$$

$$K_T x_T = 1 - K_B x_B \quad . \quad . \quad . \quad (2)$$

Combining equations 1 and 2

$$K_T (1 - x_B) = 1 - K_B x_B$$

solving for x_B

$$x_B = \frac{1 - K_T}{K_B - K_T} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

since $y_B = K_B x_B$

$$y_B = K_B \frac{(1 - K_T)}{(K_B - K_T)} \quad . \quad . \quad . \quad (4)$$

defining $\alpha = \frac{K_B}{K_T}$

gives $\alpha = \frac{y\,(1-x)}{x\,(1-y)} \quad . \quad . \quad . \quad . \quad . \quad (5)$

which is the separation factor.

By means of equations 3 and 4 and the tabulated K constants the following values of x_B and y_B are computed:

Temp. C	(1-KT)	(KB-KT)	xB	yB
85	0.546	0.700	0.780	0.900
90	0.467	0.802	0.582	0.776
95	0.375	0.910	0.412	0.633
100	0.267	1.036	0.258	0.456
105	0.151	1.166	0.1295	0.261
110	0.023	1.323	0.0174	0 040

When plotted, these data give the temperature-composition and equilibrium diagrams for benzene and toluene at 760 mm pressure shown as Fig. 7. These plots give the composition of the equilibrium vapor and liquid phases, with the temperatures on Fig. 7 representing boiling and dew points of liquid and vapors. Referring to Fig. 7 it can be seen that a mixture of 50 per cent benzene and 50 per cent toluene boils at 92 C and that the vapor in equilibrium with this mixture has a composition of 72 per cent benzene and 28 per cent toluene. The fact that the vapor from such a mixture is richer in the more volatile component is the basis for fractionation. This point is also illustrated on Fig. 8, the application of which will be demonstrated later.

Plots like the above may be constructed in the same manner for the system at higher pressures up to the maximum critical pressure of the system, i.e. the highest critical pressure of any composition, with the critical pressures of intermediate mixtures as the limits. When the maximum pressure is reached separation is no longer possible. The diagrams given as Figs. 9 and 10 illustrate the effect of pressure.

Miscible constant boiling mixtures. There are three types of binary mixtures illustrated on Fig. 11 and described as follows: (I) binary mixtures whose vapor and liquid curves on a temperature-composition plot, such as Fig. 7, do not

FIG. 9. Temperature-composition diagram for system A-B at 1 and 30 atmosphere.

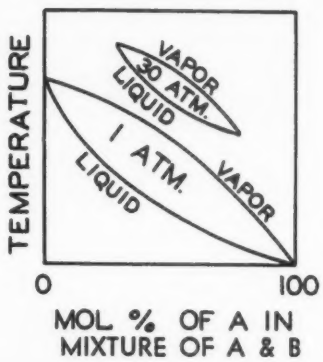
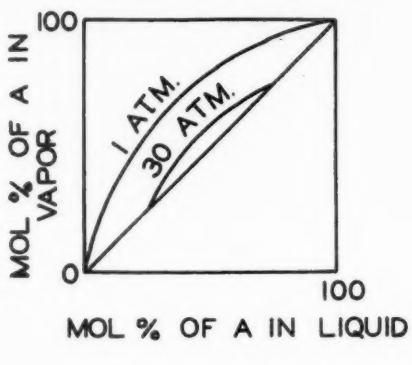


FIG. 10. Equilibrium diagram for system A-B at 1 and 30 atmospheres.



WYATT METAL & BOILER WORKS

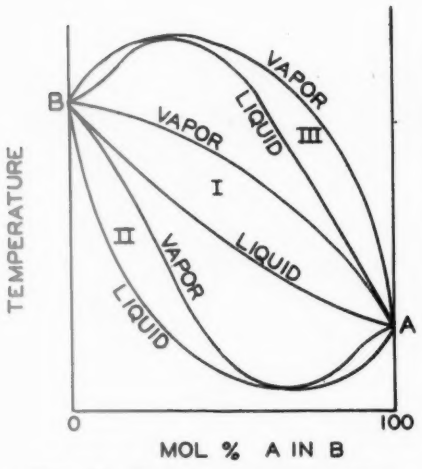


FIG. 11. Temperature-composition diagrams for three types of binary systems (see Fig. 12 for vapor pressures) at constant pressure.

touch each other between the two end points, (II) binary mixtures whose vapor and liquid temperature versus composition curves touch each other at a temperature lower than the boiling point of either component, and (III) binary mixtures whose vapor and liquid temperatures versus composition curves touch each other at a temperature higher than the boiling point of either component. The last two types of binary mixtures form constant-boiling mixtures at these points of contact. The temperature-composition plot, Fig. 11, illustrates these three types of binary mixtures where components A and B in all three mixtures have the same boiling points. These diagrams are for hypothetical mixtures presented for purposes of illustration. At these maximum and minimum boiling points, the vapor and liquid have the same composition and further fractionation is impossible. An interesting feature of these plots is the way the relative richness of vapor and liquid reverses in going from one side of the constant boiling composition to the other. For example, on the left side of the minimum boiling point for type II the vapor is richer in component B than the equilibrium liquid at the same temperature, whereas the opposite is true on the right side of the minimum boiling point. Typical of type II is the ethyl alcohol and water system. Typical of type III is the HCl and water system.

Three vapor pressure versus composition diagrams are given in Fig. 12. These illustrate the comparison of constant boiling and non constant boiling mixtures.

I. Miscible with no constant boiling point.

II. Miscible with minimum constant boiling point (maximum vapor pressure).

III. Miscible with maximum constant boiling point (minimum vapor pressure).

Constant boiling mixtures are called "azeotropes" and make possible many separations that would be very difficult or impossible without this device. This subject, azeotropic distillation, is beyond the scope of this series. However, it is of interest to recognize some of the similarities in the processes and the calculation methods.

Immiscible systems. Hydrocarbons and water are immiscible, yet mixtures of them are frequently encountered in petroleum refining, where process steam is used as a stripping agent and as a means of reducing the partial pressure of the oil. In some places where steam is used none of it condenses and there is no water present and hence the liquid mixture is all hydrocarbons and miscible, which means that one liquid phase exists. There is always a single vapor phase because steam and hydrocarbon vapors are completely miscible. In such cases the steam lowers the partial pressure of the hydrocarbon liquid in direct proportion to the amount of steam present in the vapor phase.

Where water is present, which is more often the case, three phases exist, vapor, water, and hydrocarbon liquid. In such a system, each liquid phase will exert a partial pressure equal to its vapor pressure at the temperature of the system regardless of the relative amounts of water and hydrocarbon liquid present. In other words, each liquid phase acts as if it were present alone. The sum of the partial pressures of the two immiscible phases must equal the total pressure.

For liquid mixtures that are partially miscible, i.e. each component soluble in the other at certain concentrations but forming an immiscible system at other concentrations, the above methods for miscible and immiscible systems should be used depending upon the miscibility condition of the mixture.

Complete or partial immiscibility is the key to solvent extraction and extractive distillation. The phase equilibria for a system containing a solvent must be based on experimental data. Extractive distillation calculations differ from straight fractional distillation calculations in the phase equilibrium relationships. The material balance and heat balance relationships might also differ depending upon heats of solution and mixing, etc.

The question of equilibrium is a difficult one to define clearly for absorption and fractionation because of deviations from perfect gas and ideal solution laws and because of the uncertainty regarding the approach to equilibrium, particularly in the case of absorption. As pointed out previously the use of the theoretical equilibrium plate concept with plate efficiencies makes separation calculations possible.

Deviations from perfect gas law are expressed in terms of fugacity phase distribution constants, which are derived from PVT data by application of thermodynamics. Deviations from ideal solutions may also be developed by the use of thermodynamics but for this much more experimental data are required on the phase behavior of mixtures. Also the thermodynamic applications are rather complex. For these reasons it is customary to use empirical methods of estimating phase equilibrium for higher pressures where laws of ideal solutions do not apply. Sometimes this is done in the form of corrections to fugacity K constants and sometimes by direct empirical correlations.

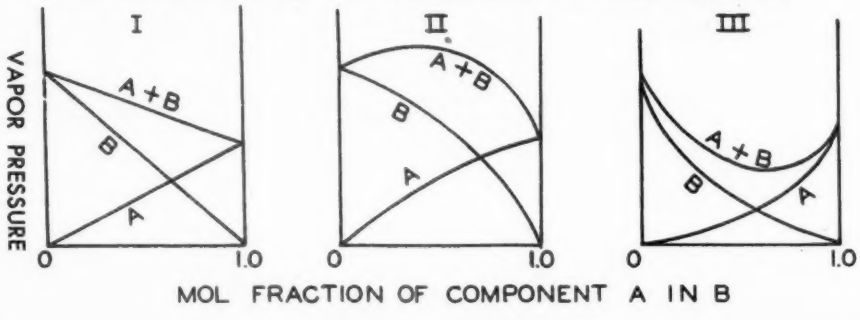
Methods of developing phase equilibria calculation tools are covered by thermodynamics. Charts and tables of equilibrium constants are available in the literature.

OPERATING LINES

The use of an equilibrium relationship through the theoretical stage and plate efficiency concepts provides a relation between the vapor and liquid leaving an equilibrium stage. When plotted on an XY diagram, an equilibrium line results. In order to carry calculations from stage-to-stage, either graphically or analytically, it is necessary to have a relationship between the vapor leaving a stage and the liquid going to it. Since these two streams are of different temperatures and since they differ in quantity by the amounts of the terminal products and the feed, two relationships are suggested: namely, *heat balance* and *material balance*. Either of these relationships would permit going from the liquid leaving a plate to the vapor going to it, or vice versa. Such a relationship is called an *operating line*. By a combination of equilibrium and operating lines, plate-to-plate calculations can be made.

This operating line concept may be explained by reference to Figs. 13 and

FIG. 12. Vapor pressure-composition diagrams for three types of binary systems (see Fig. 11 for temperatures) at constant temperature.



INCIDENTS IN SMITHway PRESSURE VESSEL RESEARCH

PROJECT No. MS-2305

How to know in advance that a pressure vessel will meet all stress requirements

FOR a hundred years the most common problem of all pressure vessel engineers has been to *know in advance* the stresses which will be developed at critical points in service.

At many critical points, designers were obliged to depend upon empirical formulae. In the past 20 years much data has been gained from destruction tests. Recently methods have been developed to arrive at stress analyses by non-destructive tests.

Extensive experience in A. O. Smith laboratories with these aids has made it possible to guide effort most rapidly and accurately in the direction of ideal design.

For example, in Project MS-2305, it was vital to avoid dangerous stresses at critical points where calculation was difficult if not impossible. Through the use of more than five years experience with the SR-4 strain-gage it was possible to determine that the new design would successfully withstand the incalculable stresses.

This experience and equipment is available to guide future vessel design involving stress problems in complicated structures.

Taking SR-4 strain-gage readings during testing of field-erected vessel.

A. O. Smith Research and Engineering Building, Milwaukee

A. O. SMITH Corporation

New York 17 • Philadelphia 5 • Pittsburgh 19 • Atlanta 3 • Chicago 4
Tulsa 3 • Houston 2 • Seattle 1 • Los Angeles 14
International Division: Milwaukee 1

MAKERS OF AUTO FRAMES • PRESSURE VESSELS • LINE PIPE • OIL-WELL CASING • BREWERY TANKS
WELDING EQUIPMENT • TURBINE PUMPS • PETROLEUM METERS • AND OTHER PRODUCTS

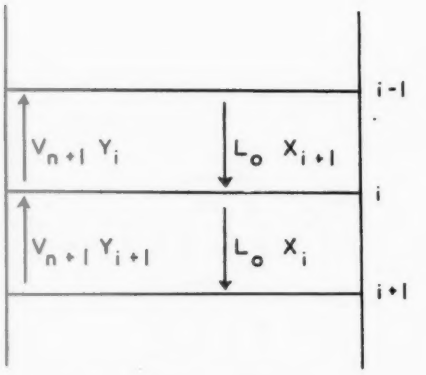


FIG. 13. Section of absorber showing nomenclature.

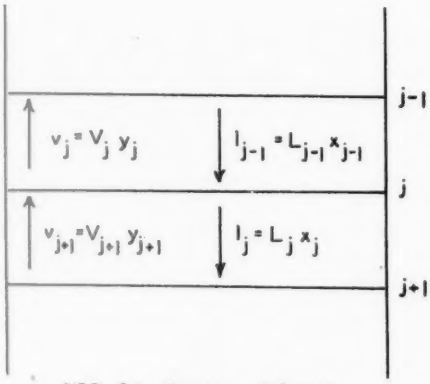


FIG. 14. Section of fractionator showing nomenclature.

14, which show sections of absorber and fractionator, respectively. For absorbers it is convenient to base liquid and gas compositions on the entering lean oil and wet gas. Thus the product L_oX_i equals the amount of any component in the liquid from the plate "i" and the product of $V_{n+1}Y_i$ equals the amount of any component in the vapor from plate "i." If plate "i" is an equilibrium stage, L_oX_i and $V_{n+1}Y_i$ are in equilibrium, which relationship is expressed by

$$K = \frac{y_i}{x_i} = \frac{V_{n+1}Y_i}{L_oX_i}\left(\frac{L_i}{V_i}\right) \quad . \quad . \quad . \quad (6)$$

A similar equilibrium expression may be written from a stripper.

The material balance operating line relationship may be obtained by making a component material balance around plate "i" and the top (or the bottom) of the absorber. This gives the following relationship

$$\frac{L_o}{V_{n+1}} = \frac{(Y_{i+1}-Y_1)}{(X_i-X_o)} = \frac{(Y_i-Y_{n+1})}{(X_{i-1}-X_n)} \quad . \quad . \quad . \quad (7)$$

The two expressions, given as equation 7, gives the operating line for absorption as a function of either terminal conditions. Equations 6 and 7 hold for multicomponent systems.

A similar material balance operating line may be written for strippers. Because of the small temperature differences in absorbers and strippers, heat balance operating lines have little utility.

Fig. 14 gives a section of the enriching section of a fractionator. It will be noted that the liquid and vapor compositions are referred to the total liquid and vapor streams. If plate "j" is an equilibrium stage, v_j and l_j are in equilibrium, which relationship is expressed by

$$K = \frac{y_j}{x_j} = \frac{v_j}{l_j}\frac{(L_j)}{(V_j)} \quad . \quad . \quad . \quad . \quad (8)$$

Equation 8 applies also in the stripping section of a fractionator.

The material balance operating line relationship may be obtained by making a component material balance around plate "j" and the top of the column. This gives the following operating line equation for the enriching section of a fractionator

$$y_{j+1} = \frac{L_j}{V_{j+1}}x_j + \frac{d}{V_{j+1}} \quad . \quad . \quad . \quad (9)$$

The (L_j/V_{j+1}) term is the slope of the operating line and the (d/V_{j+1}) term is the y intercept at $x = 0$. A similar material balance operating line equation may be written for the stripping section of a fractionator. Equations 8 and 9 apply to multicomponent as well as binary systems.

For a binary system, equations 8 and 9 may be plotted on an XY diagram as shown on Fig. 15. With constant molal overflow, the slope and intercepts of the operating line become L/V and d/V respectively.

Fig. 15 illustrates the basis for the McCabe-Thiele[3] graphical method of making two component distillation calculations. This method is described very well by Robinson and Gilliland.[5] The McCabe-Thiele method has become a classic because of the clear way it represents the operations. The use of this diagram is illustrated by the steps connecting the equilibrium and operating lines. This subject will be given more detailed attention later. It should be borne in mind, however, that the use of this method is based on constant molal overflow, which is not always realized. When the overflow to vapor ratio varies, heat balances must be made to reflect these variations. This may be done graphically for binary systems through the enthalpy-composition diagram.

Another type of operating line is the heat balance operating line, which is illustrated on Fig. 16 for a binary system. On this diagram the enthalpy of the vapor, H, is plotted against the composition of the vapor, y, giving a saturated vapor line. Also the enthalpy of the liquid, h, is plotted against the composition of the liquid, x, giving a saturated liquid line. These two lines are connected by constant temperature equilibrium tie-lines, as shown. The composition notations at the ends of equilibrium lines correspond to those on Fig. 14.

The tie-lines connecting the ends of the adjacent equilibrium lines on Fig. 16 are heat balance operating lines. The equations for these lines may be obtained by combining heat and material balance relationships around plate "j" and the

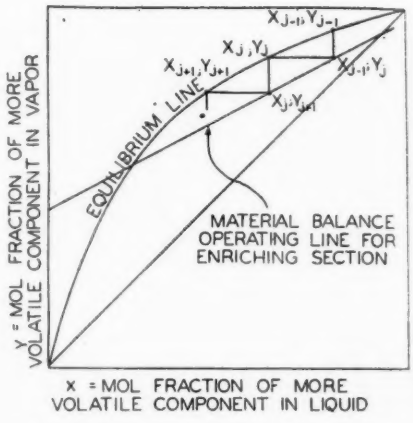

X_{j-1}, Y_{j-1}
X_j, Y_j
X_{j+1}, Y_{j+1}
X_{j-1}, Y_j
X_j, Y_{j+1}
EQUILIBRIUM LINE
MATERIAL BALANCE OPERATING LINE FOR ENRICHING SECTION
y = MOL FRACTION OF MORE VOLATILE COMPONENT IN VAPOR
x = MOL FRACTION OF MORE VOLATILE COMPONENT IN LIQUID

FIG. 15. XY diagram for binary system at a given pressure (other pressures require separate diagrams), illustrating graphical steps via equilibrium and material balance lines (see Fig. 14). This diagram is basis for McCabe-Thiele method.

top of the fractionator (see Fig. 14), which gives

$$y_{j+1} = \frac{(H_D+h_c-H_{j+1})}{(H_D+h_c-h_j)}x_j + \frac{(H_{j+1}-h_j)}{(H_D+h_c-h_j)}y_D \quad . \quad . \quad . \quad . \quad (10)$$

In this equation all enthalpies are molal quantities referred to the indicated streams. The heat removed by the condenser is referred to the distillate (i.e. ratio of heat removed to quantity of distillate) and given as h_c. A similar equation may be written for the stripping section.

The fractionation calculation method using diagrams like Fig. 16 is known as the Ponchon[4] method. This method is used where there are substantial deviations from constant molal overflow. In using this diagram, a heat balance is made graphically at each stage. The mechanism of this method will be discussed more fully later. Both Dodge[1] and Robinson-Gilliland[5] cover this method.

DEGREES OF FREEDOM

Multicomponent hydrocarbon absorption and fractionation process design involves a great many variables: number of components in feed and products, number of stages in each section, temperatures and pressures on each stage, quantities of feed and products, quantities of interstage vapor and liquid flows, compositions of feed and products, heat supplied and rejected, etc. Some of these variables are *intensive* and some *extensive* in nature. The intensive variables are thermodynamic properties of the fluids; such as, temperature, pressure, density*, entropy*, enthalpy*, etc. Intensive variables are independent of the quantities. The extensive variables are relative quantities of material and energy; such as: feed, products, interstage flows, heat supplied, etc.

In making separation design calcula-

*Specific values, i.e., per unit weight.

THE *basis* of refinery earning power—broadly referred to as "engineering know-how"—is no exception to the elementary rule which says:

"The whole is greater than any of its parts."

This company's "know how" is the total of all we have learned in designing, engineering and building more refinery units of greater capacity, for more important applications, over more years than any other organization in the industry.

★ *ONLY KELLOGG OFFERS ALL THESE:*

★ **LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

★ **24-HOUR-A-DAY PILOT PLANTS**—22 refining processes operating continuously—providing accurate data for commercial scale application.

★ **EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled . . . from the operation of both pilot plant and Kellogg-built refineries. Data extend from beginning of modern refining.

★ **PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development for more than 20 years.

★ **MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

★ **METALLURGICAL LABORATORY**—Establishes continuous check of specifications—creates new techniques for the fabrication of refining equipment.

★ **PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries . . . team-experience cuts costs, speeds construction.

★ **OPERATING STAFFS**—Specialists at placing new units "on stream"... in the training of refiner's own operating crews.

★ **LICENSING SERVICE**—Licenses available through Kellogg as Licensor or Licensing Agent for all types of refining processes.

★ **ECONOMICS CONSULTATION**—Extended experience in the field of refinery economics enables Kellogg to give authoritative counsel in the petroleum field.

PETROLEUM ENGINEERING DIVISION

THE M. W. KELLOGG COMPANY

KELLOGG

ENGINEERS TO THE PETROLEUM INDUSTRY

NEW YORK • JERSEY CITY • HOUSTON • TULSA • LOS ANGELES • TORONTO • LONDON • PARIS

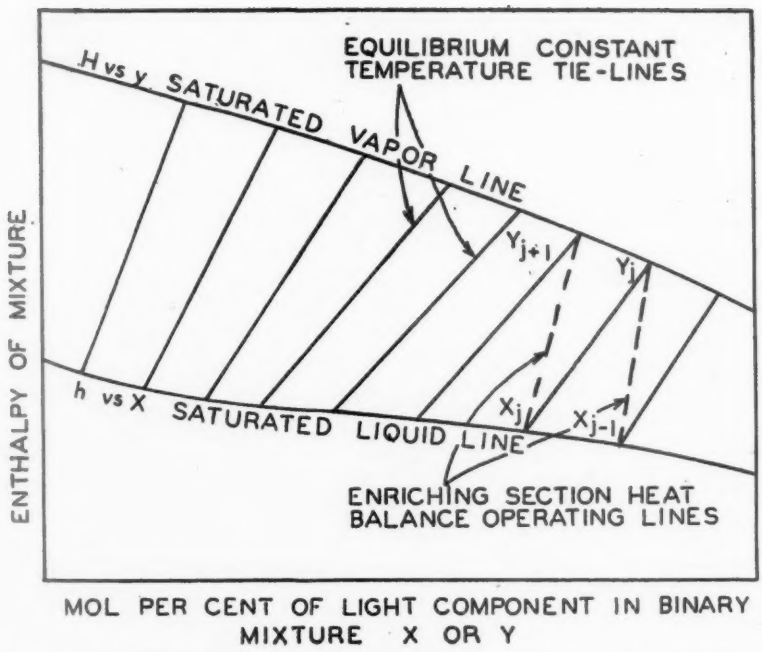


FIG. 16. Enthalpy-composition or heat balance diagram for binary system at given pressure (separate diagrams are required at different pressures), illustrating graphical steps via equilibrum and heat balance tie-line. (See Fig. 14.) Diagram is basis for Ponchon method.

tions, it is necessary to fix some of these variables at the beginning and then calculate the others. A sufficient number of these variables must be fixed before the calculations can proceed. There is a limit to the number that can be arbitrarily fixed, however. Experience is the best basis for making these initial assumptions. As a supplement to experience, a theoretical analysis of these variables may also be made. Such an analysis has been made by Gilliland and Reed.[2] This involves using the *phase rule.*

The phase rule, which is due to Gibbs, is a useful guide in many considerations of phase equilibria. By means of this law of physical chemistry it is possible to predict exactly the number of thermodynamic variables or degrees of freedom that must be arbitrarily set before an equilibrium system becomes invariant. Following is a mathematical statement of the phase rule:

$$F = C - P + 2 \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Where:

F = degrees of freedom for the system, i.e. temperature, pressure, and percentage of any component in any equilibrium phase.
C = number of components,
P = number of phases.

The phase rule is concerned with equilibrium only and applies to the intensive variables in a system at equilibrium and does not include the quantity variables. Normally process design phase equilibria problems are concerned with two phases. A system at its bubble or dew point is considered a two-phase system even though only a minute quantity of vapor or liquid is present.

As an illustration of the application of the phase rule consider the one component system water. When three phases (ice, water, and steam) are in equilibrium there are zero degrees of freedom as shown by submitting in the above equation ($F = 1 - 3 + 2 = 0$) and the system is invariant which means that neither the pressure nor the temperature may be varied without disturbing equilibrium. A two-phase water system (liquid water and steam) has one degree of freedom so that pressure or temperature may be varied without disturbing the equilibrium. Hydrocarbon absorption and fractionation process design problems are not usually concerned with more than two phases.

Although the phase rule is fundamental, it only applies to the thermodynamic intensive variables. Other variables that must be considered are the quantity or extensive variables. Thus, in hydrocarbon absorption and fractionation, both types of variables must be considered at the same time. This is done by combining the variables and the equations relating these variables. The work of Gilliland and Reed[2] covers this subject.

At this point it is of interest to point out that a theoretical analysis of the degrees of freedom, such as given by Gilliland and Reed,[2] is of more use in designing the instrumentation and control system for multicomponent separation processes than it is in making the process design calculations. An experienced process design man knows immediately what assumptions, both primary and secondary, he must make to proceed with his calculations. Instrumentation and control is a different problem. Knowing the theoretical degrees of freedom is often necessary to avoid *under* or *over* controlling.

Estimating the degrees of freedom of a multicomponent two-phase equilibrium system, involves using the phase rule for the intensive variables and in addition including the extensive or quantity variables. This can best be illustrated by considering a one stage equilibrium hydrocarbon system, such as the partial or complete vaporization or condensation of a hydrocarbon mixture. In other words, a hydrocarbon system at or between its bubble and dew points.

For this system the relative amounts of vapor and liquid constitute the additional extensive variable that must be included to augment the phase rule. In more complicated multistage systems additional extensive variables, such as heat quantities and other material quantities must be included.

For a partial condenser, where there are two phases, the variables accounted for by the phase rule are given by: $F = C - 2 + 2 = C$, where C is the number of components present. Adding to this the relative (vapor to liquid) quantity extensive variable gives $C + 1$ degrees of freedom. In order to make this system invariant it is necessary to fix one more variable than the number of components in the system.

The composition of a multicomponent system may be fixed by specifying the percentages of all but one of the components, since the percentage of one may be obtained by difference. Thus fixing the composition of the multicomponent feed to a partial condenser uses up $C - 1$ degrees of variance, leaving two variables to be specified. These two may be selected from the pressure, temperature and the relative quantities of vapor and liquid. For bubble point calculations the amount of the liquid is 100 per cent and for dew point calculations the amount of the vapor is 100 per cent. In both of these cases an infinitesmal amount of the other phase is present to satisfy equilibrium conditions.

The above discussion of partial condensation (or vaporization) and bubble (or dew) point calculations serve to illustrate the "degrees of freedom" concept.

The degrees of freedom for multistage absorbers and fractionators are obtained by analysis of the individual stage and then combining for the total stages, allowing for the equalities that occur. Non equilibrium or approach to equilibrium on individual stages is taken into account by the plate efficiency in such an analysis.

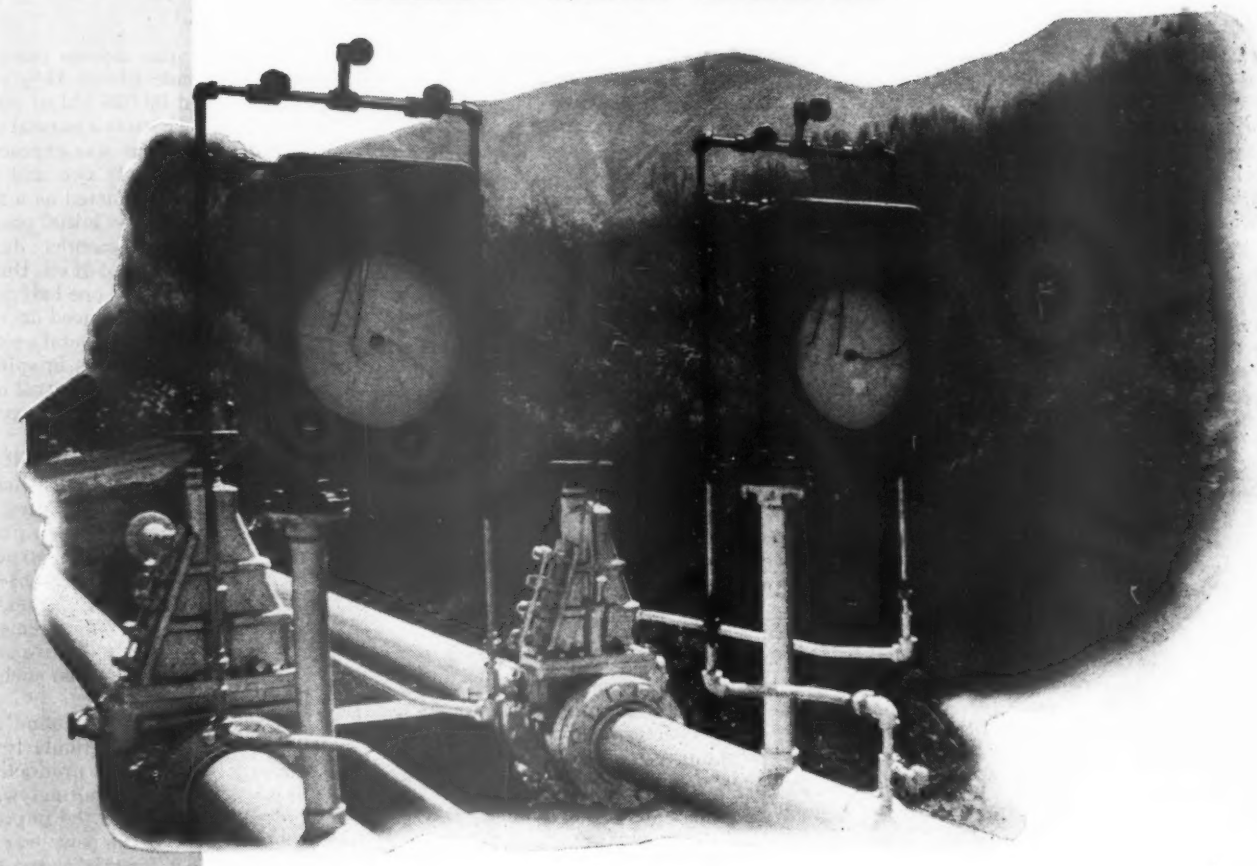
References

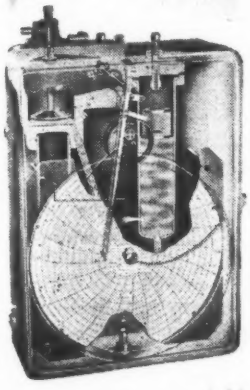
1. Dodge, B. F., "Chemical Engineering Thermodynamics," McGraw-Hill, New York (1944).
2. Gilliland, E. R., and Reed, C. E., *Ind. Eng. Chem.* 34, 551 (1942).
3. McCabe W. L., and Thiele, E. W., *Ind Eng. Chem. 17,* 605 (1925).
4. Ponchon, *Tech. Moderne, 13,* 20 (1921).
5. Robinson, C. S., and Gilliland, E. R., "Elements of Fractional Distillation," McGraw-Hill, New York (1939).

★ ★ ★

The third part of this series will be published in an early issue

Where Low-Cost Accuracy Saves Time and Labor





OUT IN THE FIELD, where maintenance is infrequent and tough conditions call for dependable measurement, you'll find that METRIC American Orifice Meters pay off in low-cost accuracy.

When adjustment becomes necessary, simple, functional design makes this quick and easy. Only three tools — screw driver, wrench and pliers are needed.

The fewest possible moving parts go into METRIC American design — only one part between the mercury and the chart record. The float is simply constructed — placed on the low side to make calibration easy. Meters can be cleaned without upsetting adjustment — adjusted without interference with working parts.

METRIC American's low-cost accuracy and easy-to-service design, proved the world over, are the result of years of measurement engineering.

Technical literature, on Indicating, Recording or Integrating Flowmeters, Pressure Regulators, Liquid Level and Flow Controllers will be mailed on request.

AMERICAN METER COMPANY

Albany · Atlanta · Baltimore · Birmingham · Boston
Chicago · Dallas · Denver · Erie · Houston · Joliet
Kansas City · Los Angeles · New York · Orlando
Philadelphia · Pittsburgh · San Francisco · Tulsa

Selection of mud fluid for completion of wells*

By H. E. RADFORD, *Mechanical Engineer*, Shell Oil Company, Inc.

● **Abstract.** A review is given of previous reports and new evidence is provided to show that damage to the productive formation does occur due to action of clay-water mud on sands as drilling proceeds. Field evidence is presented to show that use of special muds tends to reduce the amount of damage done.

The principal objective in selecting a drilling mud for completion work in a given well is to obtain the maximum productivity for that well. Each of the several special muds available have certain exclusive advantages that may result in their selection for a particular completion job. An effort has been made in this paper to point out characteristic advantages of these muds and to give examples of their use under appropriate circumstances.

Where the problem is only to prevent damage to the sand by infiltration of water it can best be solved by use of oil base mud. Where other related problems exist, as for example the presence of long sections of open hole, or where there is need for a water base electric log, or for a study of ditch shows, one of the special water base muds will be most desirable.

● **Introduction.** Efforts at improvement in drilling mud in the past have been inspired by two distinct and separate objectives. The first is the prevention of drilling difficulties such as stuck drill pipe or casing, loss of hole due to caving, excessive reaming or other mechanical troubles. The second objective is to improve productivity of wells. The latter involves protection of the oil sand during drilling against intrusion of mud particles or filtrates that may be harmful, and against formation of a mud cake on the walls that will clog the liner, and also includes the effecting of a positive and permanent water shut off by cementing. It is the second of these two principal objectives with which we are concerned in this paper.

Early improvements in drilling muds were directed for the most part to the prevention of drilling difficulties because of the greater urgency involved as deeper wells were drilled and also because the payout on the effort and expense put into the care of the mud was very apparent in reduced drilling difficulties. In recent years we have found increasing interest in attempts to improve well productivities by careful selection and treatment of the mud. In this case the actual payout is less apparent and has been the subject of considerable discussion.

● **Review of literature.** The use of special muds to improve the production of wells has been the subject of many excellent papers. Laboratory work has shown the detrimental effect of water[1, 6] and mud particles[2] on the permeability of sands. Water appears to be most damaging in the case of sands containing hydratable material, but there are other contributing factors, such as the Jamin effect and deposition of solids. Likewise, field results in general tend to confirm that use of special muds and completion procedures that reduce water intrusion to a minimum or eliminate it altogether results in wells having higher productivity[2, 3, 4, 5]. As might be expected, the evidence of improvement from use of oil base mud has been more apparent than is the case with the special water base muds and the relative value of the various water base muds has not been too clearly established.

● **Selection of type of mud.** Field data subsequent to the publishing of the above papers tend in general to support their basic conclusion that infiltration of water is harmful.

One of the most outstanding examples of the effects of water blocking as shown by field evidence is shown by a study of the production figures for two offset wells in a San Joaquin Valley field (A) shown in Table 1.

In this case only these two wells were drilled to the particular zone in question, both with water base mud. In the case of one well (a), due to deepening and plugging operations, the oil zone was open to water infiltration from the clay-water mud for five months. Before deepening this well flowed at the rate of 1100 bbl per day. When finally recompleted, after the five-months' period, its initial rate was 25 bbl per day pumping. This rate gradually built up to 67 bbl per day after nine months pumping. During an economic life of 11½ years the well produced 88,000 bbl of oil.

TABLE 1. Two wells showing influence of water block.

Well (a)
Interval open—121 ft.
Time formation exposed to mud—5 months.
Initial production before deepening—1100 bbl per day flowing.
Initial production after deepening—25 bbl per day pumping.
Maximum pumping rate reached after 9 months pumping—67 bbl per day.
Total gross production—88,000 bbl.
Economic life—11½ yr.

Well (b)
Interval open—54 ft.
Time formation exposed to mud—2 weeks.
Not deepened—Normal completion.
Initial production—1300 bbl per day flowing.
Flowing rate after 9 months—134 bbl per day.
Total gross production—98,000 bbl.
Economic life—4½ yr.

The offset well (b) was a normal completion and the oil zone was exposed to clay water mud for only two and one-half weeks. It was completed as a flowing well, 1300 bbl per day initial production. It flowed for 13 months, during which it tanked 80,000 bbl of oil. During the remaining three and one-half years of its economic life it produced an additional 18,000 bbl to reach a total production of 98,000 bbl. This was in spite of the fact that the amount of interval open was only 54 ft for well (b), as compared to 121 ft for well (a).

Thus based on interval open, well (a) should have produced at least twice as much oil as well (b). In addition, all the oil produced by (a) had to be pumped, which involved production expense while 80 per cent of the oil from (b) was produced during its flowing period. Although this is admittedly an extreme example of damage to a productive zone, it does clearly demonstrate that such action takes place.

More often than not it is found that use of special muds, particularly oil base mud, increases initial productivity of wells as compared to normal water base mud completions and the improvement appears to be permanent over the life of the well. It is for this reason that oil company managements have sanctioned the use of special muds and their development has been rapid. The problem today is to select the proper mud from the many available types to fit the conditions found in a given well. In this paper an attempt has been made to present the available data on these various special muds to assist in their proper selection and use. Examples are given of effective use of the various types.

● **Normal clay-water muds.** Normal clay-water muds serve as the yardstick by which we compare the special muds. Their performance under well conditions is better understood than that of the latter. It is well known that as drilling proceeds a filter cake is built up on the walls of the formation. Surprisingly enough, for a very wide range of permeabilities, say from 1/10 millidarcy to 10,000 millidarcys the formation permeability has no effect on the mud sheath thickness or filter loss. This is due to the fact that the permeability of a mud sheath itself is of the order of 1/1000 to 1/10,000 of a millidarcy. Thus the mud sheath itself takes control of the filter process except in the case of relatively impermeable formations having 0 to 1/10 millidarcy permeability or for very porous formations where complete loss of

*Presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Los Angeles, California, May 15 and 16, 1947, under title, "Factors Influencing the Selection of Mud Fluid for Completion of Wells."

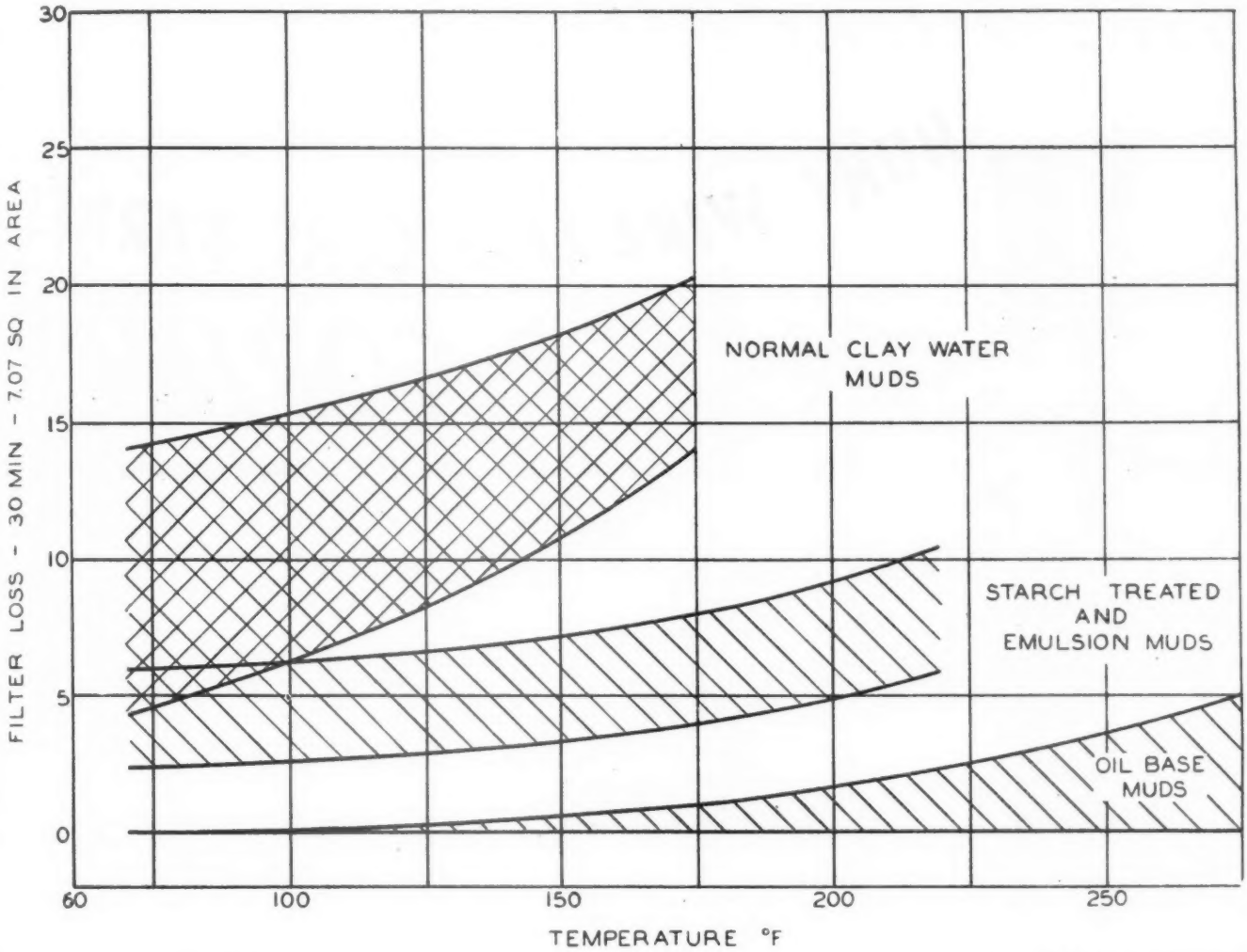


FIG. 1. Effect of temperature on filter loss values for drilling muds; 500 lb differential pressure.

circulation is experienced. We can conclude that opposite a shale having effectively a zero permeability no true mud sheath is formed. It is possible for a shale section to become plastered with cuttings, however, just as a drill collar or bit becomes "balled up."

The influence of varying pressure on thickness of mud sheath and amount of filter loss for normal muds is such that as an example, a six-fold increase in pressure differential may only increase filter loss by 30 per cent. This is due to the fact that mud sheaths deposited by normal clay water muds are found to be compressible in the manner of a sponge. Increasing pressure reduces their permeability, which tends to curb the increasing filter loss. This action is reversible. The actual compressibility of different mud sheaths varies considerably. In general, the more colloidal muds show the greatest compressibilty of mud sheath, whereas muds having a high percentage of inert material such as weight material deposit cakes that show the least compressibility.

All normal clay water muds are subject to an increase in filter loss with increase in temperature due to the decrease in the viscosity of the filtrate, which is water. Thus, theoretically the amount of filtrate should vary inversely, as the square root of the viscosity of water. Additionally, some muds suffer from high temperature flocculation. A typical filter loss temperature curve for clay-water mud appears in Fig. 1.

Normal clay-water mud is still considered satisfactory as a completion fluid in some cases, such as where the sand is but little affected by water due to lack of hydratable material, and where time and depth factors are such that but little water is lost in any case. Also, some wells are completed in wet zones and they necessarily become flooded with formation water during shutdowns of production. In such cases it may be futile to protect the sand with special muds during drilling.

● **Drilling emulsions.** One of the simplest ways of improving filter loss to a point beyond that possible by normal chemical treatment is to emulsify a certain percentage of oil into the clay-water mud. Such a mixture has been used to very good advantage in the prevention of drilling difficulties and also has some application as a completion fluid.

The filter loss can be brought down to a very low figure (+ lcc API) at room temperature. The filtrate is normally either clear water or water with a low percentage of emulsified oil. The mud sheath deposited is oil impregnated and has a soft texture. As with all water-base muds there is a rather rapid increase in fluid loss with increasing temperature as shown in Fig. 1. Comparative costs per barrel for this mud, as well as other special muds, are shown in Table 2.

One operator in a shallow field in the Los Angeles Basin has had good success in using a light mud composed of approximately 50 per cent clay-water mud and 50 per cent crude oil by volume treated with an emulsifier. The filter loss is thereby reduced to ± 1 cc API. This mud has been used with success in wells where it is necessary to set gravel packed liners, the procedure being to set the liner and to then wash thoroughly through and behind the liner with crude oil. The majority of these wells are pumped and comparative productivity indices have not been obtained.

Emulsions have the advantage of relatively low cost, ease of handling, good conductivity for electric logs, and deposit a soft easily decomposed mud sheath. The advantage or disadvantage of having a filtrate with a low surface tension such as these muds often have due to the presence of the emulsifier, has not been thoroughly explored.

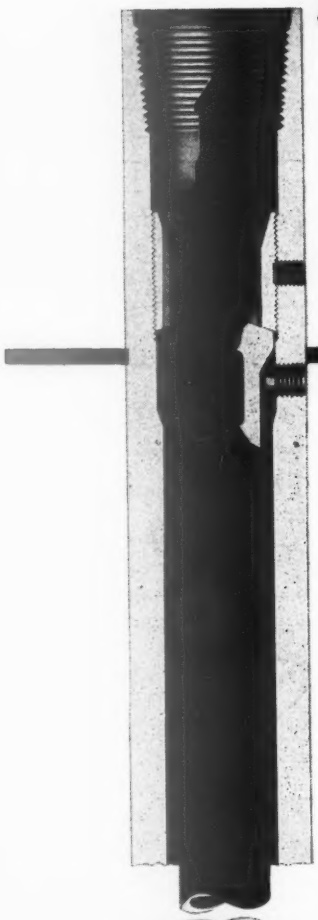
● **Starch muds.** Of the various organic colloids available, starch has been the

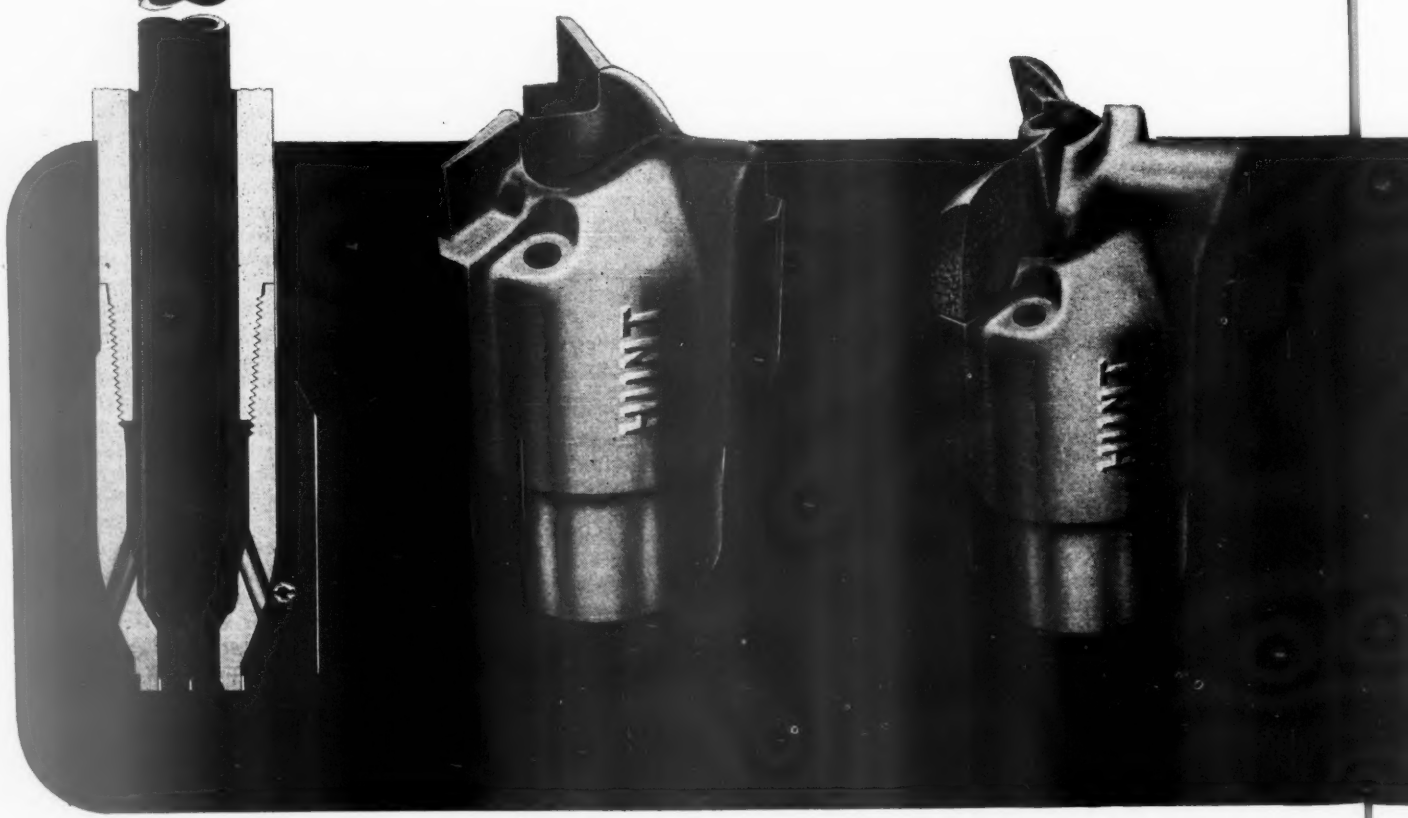
NEW-IMPROVED

HUNT WIRE LINE CORE BARREL...F

FASTER CORING

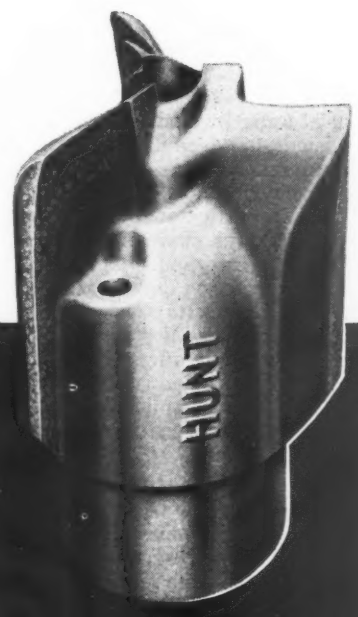
This new design Hunt Soft Formation Core Cutter Head and blades is a single unit with forged alloy steel heat treated blades. Replace it right in the field.





L...FEATURING A NEW DESIGN BIT HEAD FOR and DRILLING SPEEDS

Again . . . Hunt has brought a really new design Wire Line Core Barrel to the field that gives operators faster drilling and coring speeds. One of the new, outstanding features is the soft formation wire line coring bit head . . . with replaceable blades and core cutter head . . . which brings basically the same features to the field as the revolutionary Hunt Export Model Welded-in Blade Bit. Blades and core cutter head can be replaced in the field. Core catchers as well as other parts throughout the Hunt Wire Line Core Barrel have been greatly improved to provide positive core results. In addition, this new Hunt Wire Line Core Barrel gives increased diameter cores for better core recovery. Its simple design permits easy operation. Less parts required means less initial cost and reduced inventory. Then, the Hunt Core Barrel adds the field-proved floating inner barrel with positive hold down that means better core recovery with less chance of missing the core. This new Hunt Wire Line Core Barrel, with the replaceable blades and core cutter head, is especially adaptable for foreign operators. Write for complete details.



CUT EVERY CORE WITH NEW, SHARP BLADES AND NEW CUTTER HEAD

HUNT TOOL COMPANY

HOUSTON · TEXAS

FIELD SHOPS: Houston, Bay City, Corpus Christi, Jennings, Harvey
EXPORT SALES: Hunt Export Company, 19 Rector St., New York
Advo. Pte. R. Saenz Pena 832, Buenos Aires

A BUSINESS BUILT ON *Good* SERVICE

most common additive for water loss reduction. Starch is adaptable to mixing in the following ways:

1. Low pH fresh water muds with preservative.
2. High pH caustic mud without preservative.
3. High pH lime base mud without preservative.
4. Salt-water base mud with preservative.

Filter losses at room temperature as with the emulsions can be made very low and typical high temperature characteristics are shown in Fig. 1.

One of the best applications for a starch mud occurs where it is desired to drill through the oil sand before setting a water string and to then cement a solid string of casing on bottom for selective gun perforation. The starch mud can be handled safely and economically with long sections of open hole, it tends to protect the sand with its low water loss, and particularly in the case of the lime base mud provides a compatible fluid for cementing. Obtaining a successful primary cement job over a long section of casing is aided materially by use of a low viscosity, low gel mud that will not thicken when contaminated by cement.

Starch muds can be prepared so that the filtrate will match formation water in salt content and, although this has theoretical advantages, field evidence as to its value has not been encouraging.

Field results comparing well productivities in a relatively deep zone in San Joaquin Valley field (C) for wells completed with oil base mud, starch mud, and water base mud are shown in Table 3. In the case of the starch mud the productive zone was drilled with fresh water starch mud and was reamed from 8½ to 11 in. while using 1000 grain salt water starch mud.

● **Carboxymethylcellulose muds.** An organic colloid named carboxymethylcellulose [7] is coming into use in the Mid-Continent area as a water loss reducer. The material is not fermentable and does not require maintenance of a high pH. It has been found useful in preparation of salt water muds having a low water loss.

It has not been used extensively in areas where productivities can be compared[8]. Also because of limited manufacturing capacity the cost per pound of the material is high at present ($.70 to $.75).

Its use is mentioned in this paper in order to cover completely the list of available muds.

● **Crude oil.** Crude oil has been used rather extensively in the past as a completion drilling fluid in shallow zone drilling. This procedure is limited to fields where pressures are low and where no difficulty is experienced with caving shale. Straight crude oil has no plastering properties but when mixed with cuttings and formation fluids it acquires some plastering ability.

In one shallow (2000-4000 ft) field (D) in the San Joaquin Valley results were studied in a group of 56 wells,

TABLE 2. Costs.

Type of mud	Average cost per bbl	Salvage value after use
Normal clay-water mud	$ .50—$1.00	good
Drilling emulsions	$2.50—$3.50	good
Starch muds	$2.50—$3.50	Poor for some types — good for others.
Carboxymethylcellulose muds	$3.00—$4.00	.....
Crude oil	$1.50	good
Oil base mud	$8.50	May require reconditioning.

TABLE 3. Productivity indices for wells completed with clay-water, oil base, and starch mud. Field C.

Group 1

Well	Type completion	Initial productivity index	Initial specific productivity index
A	Water base	0.63	0.00243
B	Water base	0.46	0.00173
C	1000 gr./gal starch	1.18	0.00453
D	Oil base	1.22	0.00500

Group 2

A	Water base	0.46	0.00159
B	100 gr./gal starch	0.33	0.00118
C	Oil base	0.35	0.00125
D	Oil base	0.84	0.00307

among which 19 were completed using crude oil as a drilling fluid, 18 with water base, and 19 with oil base mud. Pressure and permeability measurements were not available so that the comparison was on a production factor per foot of sand basis. Results tended to be erratic but showed a trend in favor of oil as compared to water base mud, both initially and after one to three years production. The choice between oil base mud and crude oil was inconclusive.

● **Oil base mud.** Oil base muds have characteristics that in general make them very useful as a completion fluid. They have the lowest filter losses and therefore the thinnest filter cakes of any of the mud fluids, particularly under well conditions (see Fig. 1). Also, the filtrate is oil, which is not harmful to the formation.

Principal disadvantages are the high cost per barrel, the special care and procedure required in their use at the well, and the fact that oil base electric logs are not equivalent to water base electric logs in every respect.

Although cementing in oil-base mud involves the hazard of contaminating the cement with oil, this is offset by the fact that holes drilled with oil base are usually true gauge, without washouts, and the mud having a low gel strength can be displaced freely from the well.

As mentioned before, numerous examples exist where it can be shown by field data that initial productivities can be improved through its use. As to the permanence of the effect, a study of wells in San Joaquin field (E) indicates that it extends over at least a substantial portion of the life of the well. In this field excellent information in regard to permeabilities and pressures is available for comparison of four water base and four oil base wells. Initial specific productivity indices for oil-base mud wells range from 50 to 200 per cent higher than those of the clay base wells. After a period of six to seven years this relationship still exists.

A recent excellent example of the application of oil base mud to a specific problem occurred in a Coastal Field (F). A high pressure zone consisting of fine grained sand of low permeability is located at 9000 ft ±. When completed with conventional 90 to 100 lb muds and conventional liners, the wells tend to fill in with sand—thus blocking production. Various liner perforation sizes from 40 mesh slots to ⅜-in. round holes have been tried. It was not thought advisable to use finer mesh perforations with clay-water muds because of the possibility of the liner becoming clogged with mud sheath. A recent well in this zone was drilled with oil-base mud, and a 0.015-in. mesh slotted liner was run. No washing behind the liner was attempted because of the high pressure of the zone, but the well was completed satisfactorily with an initial productivity index approximately three times better than nearby water-base completions and with indications of improved sand exclusion.

● **Conclusions.** Substantial field evidence exists to show the harmful effects resulting from contact of normal clay-water muds with an oil sand. It would therefore, be logical from a technical standpoint to use either oil-base mud or crude oil as a completion fluid in every well to avoid any infiltration of water into the sand. From a practical standpoint, however, cases are found where either normal clay-water mud, or one of the special water base muds such as drilling emulsions, starch mud, or carboxymethylcellulose mud can be used logically and on a sound economic basis. The selection of the particular special water mud to use requires analysis of well conditions to be met, and adaptation of the mud best suited to those conditions.

Under circumstances where sands have low permeability and at the same time are strongly affected by water, or where a particularly thin mud sheath is required, use of oil-base mud is definitely indicated and the payout is apparent.

● **Acknowledgment.** Appreciation is expressed to Shell Oil Company, Inc., for permission to publish this paper.

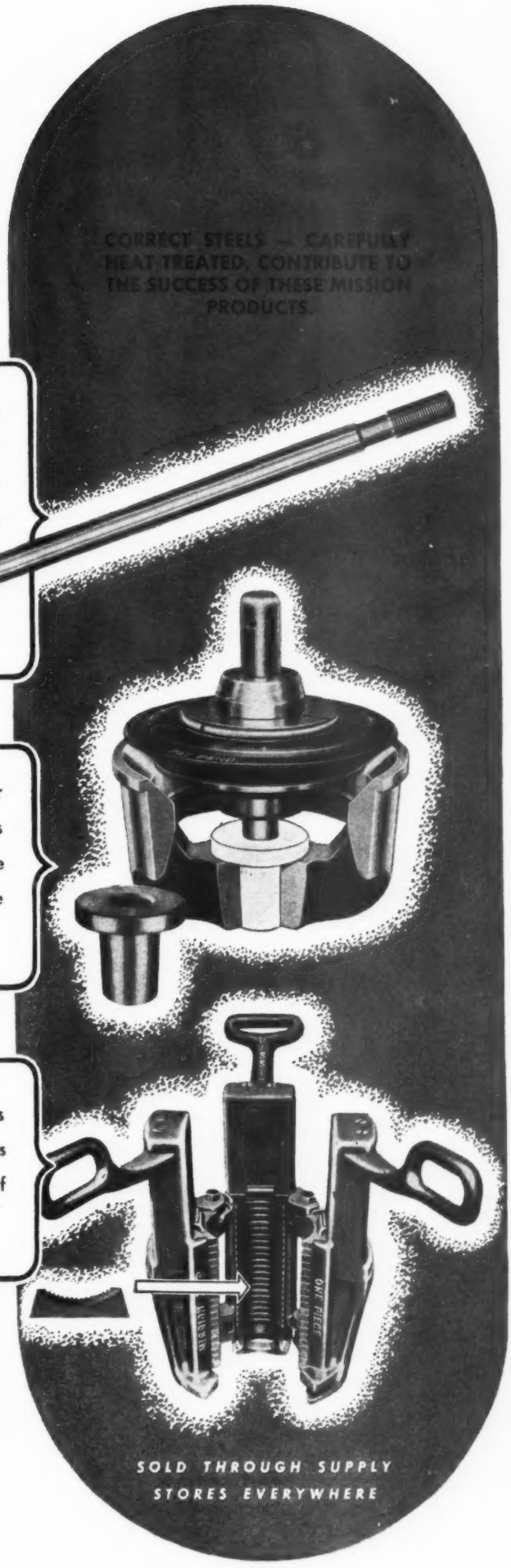
Special acknowledgment is made of suggestions and data received from other oil companies and their personnel.

● **References.**

1. "Water Permeability of Reservoir Sands," Norris Johnston and C. M. Beeson, *AIME Petroleum Technology*, May, 1945.
2. "Review of Special Water-Base Mud Developments," W. R. Kelley, T. Fenton Ham, A. B. Dooley, API Paper, April, 1946.
3. "Results and Use of Oil Base Fluids in Drilling and Completing Wells," Glen V. Kersten, API Paper, April, 1946.
4. "Oil Base Drilling Fluid Often Boosts Production," A. W. Alexander, *Oil Weekly*, Vol. 115, No. 1.
5. "Drilling Fluid for Completion of Shallow Oil Wells," W. H. Farrand and W. A. Clark, API, March, 1944.
6. "The Drowning and Revival of Gas Wells," S. T. Yuster and K. J. Sonney, *The Petroleum Engineer*, April, May, and June, 1944.
7. "Improved Drilling Muds Containing Carboxymethylcellulose," H. H. Kaveler, API Paper No. 851-20 C, June 6, 1946.
8. H. H. Kaveler, personal communication to the author, March 1947.

★ ★ ★

Examples of
MISSION LEADERSHIP IN
Metallurgy and Heat Treating



To solve the problem of rod breakage and the resultant damage to pump, Mission instituted an intensive search for the steel with the best possible combination of strength and toughness. Extensive tests by Mission metallurgists resulted in the tough high-strength Mission rod that bears the Mission special guarantee which covers damage to the pump as well as replacement of the rod.

Steel requirements for maximum hardness differ from those for maximum toughness. The Mission Silver Top Valve design permits making the wear-taking bushing for maximum hardness and the valve seat for maximum toughness. This results in better valve service for Mission customers.

Mission metallurgists experimented with hundreds of combinations of steel and heat treating to get the greatest practicable hardness of Mission slip dogs. This extreme hardness is your assurance of the long life and positive grip of Mission slips.

Mission
MANUFACTURING CO.
HOUSTON, TEXAS

Export Office: Room 1636, 30 Rockefeller Plaza, New York 20, N. Y.

SOLD THROUGH SUPPLY STORES EVERYWHERE

Control of unconsolidated sands in Wilmington oil field*

By READ WINTERBURN, *Chief Petroleum Engineer,*
Union Pacific Railroad Company

● **Abstract.** Study of the performance records of 260 wells in the Wilmington field reveals that almost completely effective control of the unconsolidated sand of the Tar, Ranger, and Upper Terminal zones has been accomplished in wells that are equipped with prepacked liners using gravel ranging in diameter from 0.093 in. to 0.131 in., or gravel packed liners using gravel of 0.131 in. to 0.187 in. diam or smaller.

Wells equipped with liners designed effectively to screen sand have exhibited more rapid decline of productive capacity than those with conventional liners. However, comparison of the production and economic returns from the two groups of wells indicates that greater profits were realized during the first seven and one-half years from the wells with liners designed to screen sand. This was the result of the lower production costs, absence of redrill jobs, and the ability of these wells to produce at higher rates without sanding up. It is anticipated that cost of restoring productivity to wells with plugged gravel-type liners will be no more than the cost of redrilling wells having conventional liners.

PRODUCTION from the Tar, Ranger, and Upper Terminal zones in the Wilmington field has been made difficult and expensive because of the fine, unconsolidated nature of the sand in these zones. This sand heaves into the well, sanding up pump and liner and necessitates frequent cleanout jobs. It enlarges perforations by abrasion and often causes collapse of liners. Most wells that produce appreciable quantities of sand eventually reach a condition that necessitates redrilling and installation of new liners in order to maintain the wells on production.

Much thought and effort have been directed toward the solution of this problem, and published material covers the experimental background and most of the equipment and practices that have been applied in the field.

The efforts to control sand have fallen under two general headings: (1) Control of the flow of fluid into the well so as to prevent the entrance of excessive quantities of sand, and (2) the use of a liner that will effectively screen the sand.

The control of flow of fluid into the well consists mainly of preventing surging and excessive velocities. Efforts to accomplish this have consisted in restricting production rate, providing a maximum area of perforations for fluid entry, producing with tubing near the bottom of the zone to prevent filling the liner with sand, or pumping with tubing high to maintain constant back pressure against the sand. C. J. Dean[1] has discussed many of these factors in detail.

Screening of sand has been attempted by the use of slots and round holes of the smallest available dimensions, by pumping gravel of a selected size into the annulus between the perforated liner and the walls of the hole, or by "prepacking" the liner before it is run in the well by filling the annulus between the liner and a perforated outer sheath with gravel.

C. J. Coberly and E. M. Wagner[2] have presented extensive experimental work in which they determined that a slot width of twice the grain size at the 10 percentile point on the cumulative screen analysis will effectively screen the sand. On this basis the finer sands in the Wilmington field would require a 20-mesh slot.

Kenneth E. Hill[3], B. Gumperts[4], and Coberly and Wagner[5] have presented the results of extensive experimental work relative to the proper ratio of gravel size to the sand grain size at the 10 percentile point on the cumulative screen analysis. The conclusions arrived at in this work varied in the recommended gravel size from 8 to 13 times (for the coarsest gravel in the mixture) the 10 percentile sand grain sizes. These experiments indicated that velocity of fluid movement affects the ratio between the grain sizes of gravel and sand which is needed for foundation of stable bridges. Velocities in producing wells are much lower than those used in the experiments.

Actual experience in the field has shown that sand entry can virtually be eliminated by use of a gravel, the finest 50 per cent of which is approximately 10 times the grain size at the 10 percentile, of the finest sand to be screened.

Hill also presented evidence that supported his conclusion that gravel packed and prepacked wells had lower initial productive indices than comparable wells completed with conventional liners and that the decline in index was more rapid in gravel packed or prepacked

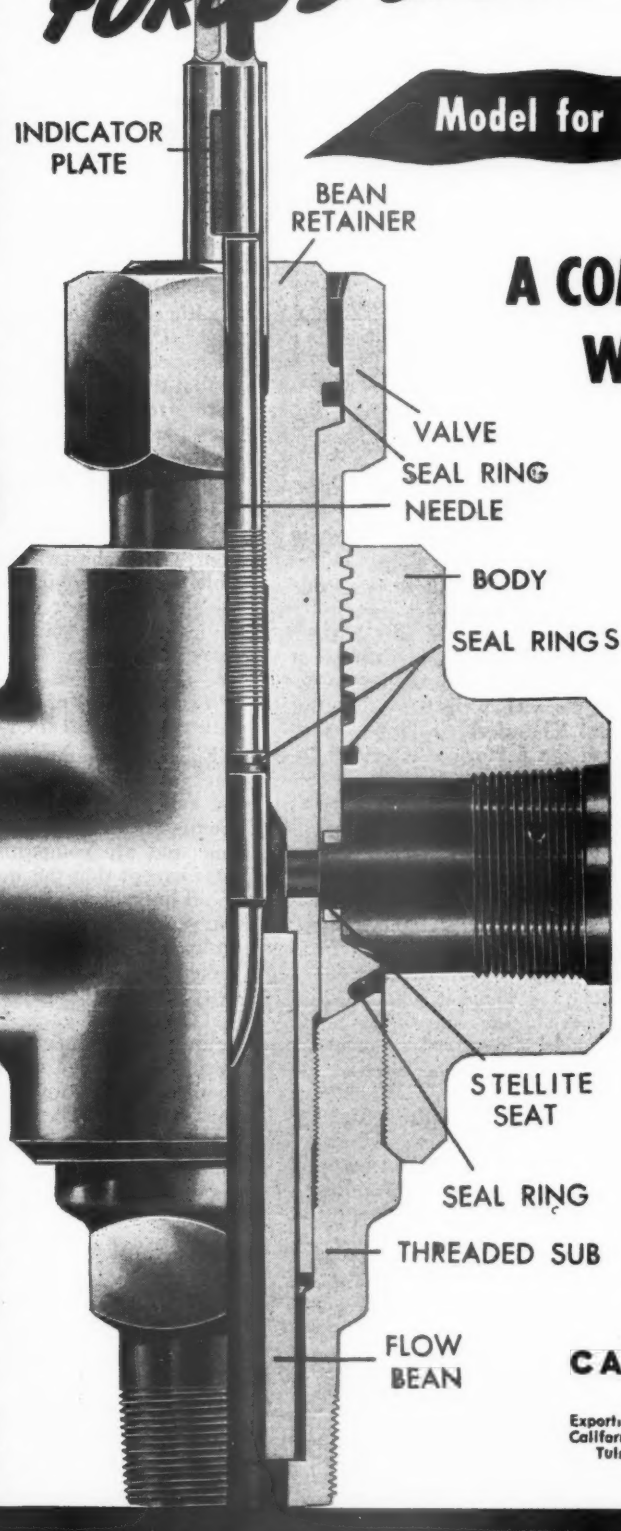
TABLE 1

Type of liner	Total wells	Time since first use	No. of wells known to have bad pipe, per cent	No. of wells that have been redrilled, per cent	Cumulative per cent of redrills by the end of each year after completion									
					1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
I 60 M slots	95	10 yrs.	45 (47.4)	34 (34.8)	4	7	10	15	16	20	27	31	34	36
II 30 M slots	10	2 yrs. 7 mos.	4 (40.0)	3 (30.0)	0	30	30							
III ⅛" R.H.	25	1 yr. 10 mos.	5 (20.0)	4 (16.0)	4	16								
IV Gravel pack 0.093-0.131 0.131-0.187	38	8 yrs. 4 mos.	2 (5.3)	1 (2.6)										
V Gravel pack 0.187-0.250	3	3 yrs. 7 mos.	0	0										
Total of IV and V	41		2 (4.9)	1 (2.4)	0	0	0	0	0	0	2			
VI Gravel pack 0.250-0.375	23	3 yrs. 4 mos.	4 (17.4)	3 (13.0)	4	9	13							
VII Prepack 0.093-0.131	35	7 yrs. 8 mos.	2 (5.7)	1 (2.9)										
VIII Prepack 0.131-0.187	2	7 yrs. 8 mos.	0	0										
IX Prepack 0.093-0.250	8	10 mos.	0	0										
Total of VII, VIII, and IX	45		2 (4.4)	1 (2.2)	0	0	2	2	2	2	2			
X Prepack 0.187-0.250	27	2 yrs. 8 mos.	3 (11.1)	2 (7.4)	4	7	7							
XI Wire wrapped liners 0.015-0.020	4	1 yr. 3 mos.	2 (50.0)	0										
	260													

*Presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Biltmore Hotel, Los Angeles, California, May 15-16, 1947.

THE NEW CAMERON TYPE "F" FORGED STEEL FLOW WING

Model for COMPACTNESS and SIMPLICITY



A COMPLETE CHRISTMAS TREE WING IN A SINGLE UNIT

The Cameron Type "F" Forged Steel Flow-Wing for 3,000 lbs. working pressure is the latest addition to the Cameron line of Flow-Wings. It provides in a single compact unit either an adjustable or positive flow bean plus a wing valve for choke changing. It is illustrated at left fitted with an adjustable flow bean, and may be converted to a positive type choke by simply replacing the needle with a bleeder plug and inserting a positive type bean of the desired size.

In the accompanying illustration, the valve section of the unit is shown in open position. It is closed (see below) by screwing the valve down to its seat, using an all-purpose wrench which fits the hex on the valve stem. A coarse thread is provided between the valve stem and body for speedy opening and closing of the valve. The valve and its seat are faced with hard metal to resist cutting. All component parts of the unit may be replaced in the field without removing the flow-wing from the well.

The bean retainer, which screws inside the valve stem, may be easily removed when it is necessary to replace beans, utilizing the same wrench as above. As a safety measure, it is impossible to remove the flow bean unless the valve is in closed position.

An indicator plate, graduated in increments of 1/64 inch, is provided to facilitate adjustment of the choke to meet production requirements. The all-purpose wrench also fits the adjustable choke stem.

Available in studded body models or threaded, as shown. Complete details will gladly be sent to interested operators on request.

CAMERON IRON WORKS, INC.
P. O. BOX 1212, HOUSTON, TEXAS

Export: 74 Trinity Place, New York, N. Y. West Texas: Odessa, Telephone (1710). California: 1442 Hayes Ave., Long Beach (7-2036). Oklahoma: 310 Thompson Bldg., Tulsa. Wyoming: 356 N. Wolcott St., Casper. North Louisiana: Bossier City (P.O. Box 425).

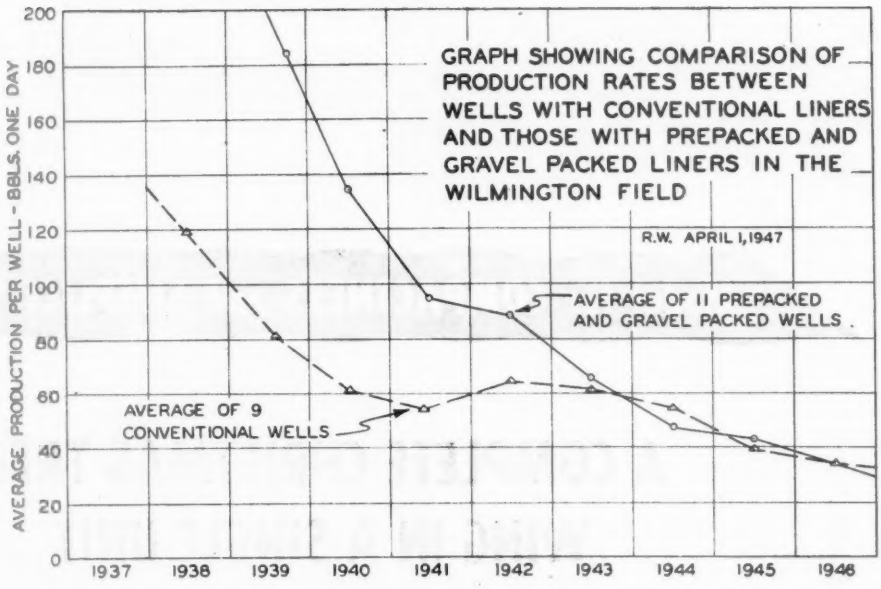


FIG. 1

wells that are designed to prevent entrance of all sand.

These effects are believed to be the result of failure to remove the wall cake before completion and the plugging that occurs during production due to the bridging of progressively finer material at the outer face of the gravel sheath.

Considerable experimentation was conducted with liners other than the 50, 60, and 80-mesh slots that were used in the early wells and the gravel packed and prepacked liners designed effectively to screen all sand. This experimentation was directed toward devising a liner installation that would prevent the serious sand trouble that developed in the early wells and at the same time avoid the plugging that occurred in many of the gravel packed and prepacked wells.

Gravel size in prepacked liners was increased from 0.093-0.131 in. to 0.187-0.250 in. and in gravel packed wells from 0.131-0.187 in. to 0.250-0.375 in. Liners with 30-mesh undercut slots and 3/32-in. round holes were also installed in a number of wells. One operator installed wire wrapped liners in four wells.

Some of the wells with each of these new types of liners produced sand initially and in a number of them it was necessary to bail or circulate sand from the hole. This had been anticipated but it was hoped that the production of limited amounts of sand would prevent the plugging that occurred with the gravel sizes previously used.

A total of 260 wells in the Wilmington field have been studied in order to determine the effectiveness of various types of liner installations in preventing the trouble that results from sand production. In analyzing the performance of these wells it was decided to use the percentage of wells that have developed bad liners and the percentage that have been redrilled as criteria for determining the effectiveness of various types of liners. The results of this study are shown in Table 1.

It will be noted that there is a wide discrepancy in the average length of time the various types of installations have been in use. It is further apparent that liner failures are continuing to occur among the early wells ten years after completion. Therefore, it is necessary to compare the performance of the various types of liners on some basis that includes the time factor. To accomplish this, a tabulation has been prepared showing for each type of liner the cumulative percentage of redrill jobs that were performed between completion and the end of each year following completion.

It will be noted from inspection of Table 1 that the 30-mesh slots, 3/32-in. undercut round holes and 0.250-0.375-in. gravel packs have a performance record that is not as good as that of the 60-mesh slots while 0.187-0.250-in. prepacked liners are very little better. On the other hand, gravel packed liners (those in which the gravel is pumped down around the outside of the liner) with 0.131-0.187-in. or smaller gravel, and prepacked liners with 0.093-0.131-in. or smaller gravel have required only about one-tenth the percentage of redrilling as the 60-mesh slots after seven years' experience. The absence of redrilling with the 0.187-0.250-in. gravel packs and 0.131-0.187-in. prepacks is not considered conclusive because of the small number of wells involved. Experience with prepacks using 0.093-0.250-in. gravel to date indicates that results will be comparable to those obtained with 0.093-0.131-in. Although none of the four wells with 0.015-in. and 0.020-in. wire wrapped liners have been redrilled, two of them have made considerable sand and have developed bad pipe.

Some wells have recently been equipped with liners having slots of 0.015-0.025-in. width and are producing satisfactorily; however, the history on these liners is too short to justify any conclusions. It is possible that sufficiently narrow slots or sufficiently small round holes will effectively screen the sand and can be more easily cleaned should they become plugged than can the gravel packed and prepacked liners.

The foregoing review indicates that sand trouble can be successfully prevented in nearly all cases at Wilmington by using the proper size of gravel in gravel packed or prepacked liners. However, it has been observed that there is a more rapid decline in productivity of wells with these liners than is the case where conventional liners are used. This has been established by observation of the productive indices during the flowing life as reported by Hill[5] and Winterburn[6]. Unfortunately, indices have been measured only during the flowing life so that the decline cannot be determined during recent years since the wells have been placed on the pump; however, the decline in actual production rates indicate that the same relation has continued.

In spite of this effect, study of production records shows that it has been possible to maintain higher rates of production for a number of years from wells equipped to screen sand effectively because it is not necessary to restrict the wells to avoid excessive sand production as it is in the case of those wells equipped with conventional liners.

Fig. 1 shows the average production rate per well of two groups of wells to the end of 1946. The wells in the two groups are in the same fault block and zone and are comparable in all other ways except that the wells with conventional liners were completed from one to two years earlier than those in the other group and for this reason might be expected to have higher initial productivity. Inspection of this graph shows that the gravel packed and prepacked wells were produced initially at higher rates and declined more rapidly so that during 1946 the two groups produced at nearly equal rates.

In order to evaluate the economic aspect of using the two types of liners, the following comparison of the average well in these two groups has been made:

	Average per well of 11 gravel packed and prepacked wells	Average per well of 9 conventional wells
Length of time on production	7½ yrs.	9 yrs.
Recovery to Jan. 1, 1947, bbl.	205,000	206,000
Recovery at end of first 7½ years	205,000	171,000
Value	$217,000	$180,000
Original drilling cost	$ 38,300	$ 33,800
Cost of pulling and cleanout jobs	$ 1,000*	$ 3,000
Cost of redrilling jobs	..	$ 5,000†
Net return before paying taxes, overhead, and ordinary lifting expenses	$177,700	$138,200

*Includes cost of experimental washing and gun perforating two wells to increase productivity.

†Prorated cost of redrilling 3 wells to 9 wells.

HUGHES ROCK BITS...

WORLD'S *Heavyweight* CHAMP

When high strength formations such as dolomite, chert, quartzite, etc. are encountered, Hughes Engineers recommend the application of heavy weight by use of drill collars for greater rate of penetration and more hole per bit. The rugged design of Hughes Rock Bits affords maximum safety in application of extremely heavy weight and correspondingly slower RPM. Reports from many fields confirm this recommendation and show a marked increase not only in rate of penetration but in footage per bit as well.

The ability of Hughes Tricone Rock Bits to "take it" under conditions of extremely heavy weight drilling in very dense formations is another example of approaching every drilling problem with a proven method accepted by the oil drilling industry as an "engineered solution"!

Hughes TOOL COMPANY HOUSTON, TEXAS

Standard of the Industry

Protect Your Gauges And Recorders From Surging Pressures With The

MARTIN-DECKER PULSATION DAMPER

THE MARTIN-DECKER Pulsation Damper is a pressure gauge damper of proven merit, fully adjustable, easily cleaned, for use in connection with gauges operating under pulsating pressures. It can be used on air, gas, oil, water, steam, gasoline pressure lines, etc. Dampens out slow or rapid pulsations with the smallest possible amount of drag or time lag. Installations can be made in any position desired without affecting efficiency. Quickly pays for itself by protecting gauges and recorders from damaging pressure surges. Operates under pressure of minus 0 to 10,000 lbs.

Write for descriptive literature.

MARTIN DECKER CORP.
LONG BEACH CALIFORNIA

From the above figures there can be no doubt as to the economic advantages indicated by a comparison of the performance during the first seven and a half years of the life of the group of conventional wells with that of the prepacked and gravel packed wells.

There remains, however, the problem of producing the zone to depletion through gravel packed and prepacked liners. A number of wells have already declined to rates of 5 bbl a day or less in spite of the known ability of the formation at the particular location to produce at many times this rate. This has been demonstrated by greatly increased productivity after gun perforating.

No uniformly successful method of correcting this condition has yet been developed. Some wells have been improved, however, at least for several months, by washing with hot oil. Recent use of chemicals in washing plugged liners has yielded good early results in a sufficient number of cases to foster the hope that a solution of the problem may be found in this direction. Experimental gun perforating has increased the productivity of some of the wells in which it has been tried but has also been the cause, in some cases, of loss of ability to control sand production without greatly restricting the rate of production.

The fluid used in drilling through the producing zone and the steps taken to clean the hole and the perforations in the liner have an important bearing on the performance of the wells. All wells used in the economic analysis were drilled with ordinary clay base mud, the only difference in completion being that most of the gravel packed and prepacked wells were washed by circulating fresh water out through the liner before being placed on production.

Recent Tar, Ranger, and Upper Terminal zone wells have been drilled through the producing zone with oil base or emulsion drilling fluid or with specially treated low water loss muds. Most of the wells are thoroughly washed, many operators making a regular practice of using wall scratchers, moving the liners and circulating oil or salt water during the washing process. No attempt is made to evaluate the results of these practices since the principal purpose is to investigate the effectiveness of various types of liners in preventing sand trouble. It should be remembered, however, that having all possible perforations open and providing that all portions of the zone are in condition to contribute production are important factors in reducing velocity and preventing excessive sand production when liners are used that are not designed to screen all sand.

The method of controlling sand that consists of controlling the fluid flow into the well has not been successfully applied to any large number of wells. Even pumping with tubing high or with back pressure regulators on the casing has not prevented sand trouble. Restriction of production rates was necessary in nearly all the early wells to prevent immediate sanding up but liner failure and redrilling have been common even among the wells with conventional liners that were most severely restricted. From the performance record, it is concluded that successful application of this method at Wilmington would involve restricting wells to much lower rates than has yet been attempted. Under the competitive conditions that exist at Wilmington, this would undoubtedly result in drainage losses of such magnitude as to make the system impractical.

● **Conclusions.** The study of performance and the economic analysis outlined herein have led to the following conclusions with regard to type of liners to be used in wells drilled to the Tar, Ranger, and Upper Terminal zones in the Wilmington field:

(1). Sand can be successfully controlled through the use of 0.131-0.187-in. or smaller gravel in gravel packs and 0.093-0.131-in. or smaller gravel in prepacks. (Early performance of prepacks using 0.093-0.250-in. gravel indicates results similar to those obtained with 0.093-0.131-in.)

(2). Use of larger gravel as well as slots of 0.030-in. width, round holes of 3/32 in. diam, and 15 or 20-mesh wire wrapped liners will not prevent sand trouble.

(3). Final conclusions as to results to be obtained with slots of less than 0.030 in. width cannot be arrived at due to the relatively short experience in most of the wells so equipped.

(4). Plugging of gravel packs and prepacks causes a more rapid decline in productive index than that which occurs when conventional liners are used.

(5). Greater economic returns during the early history are realized from gravel packed or prepacked wells designed to screen all sand due to ability to produce at higher rates without sand trouble and because of the lower production costs.

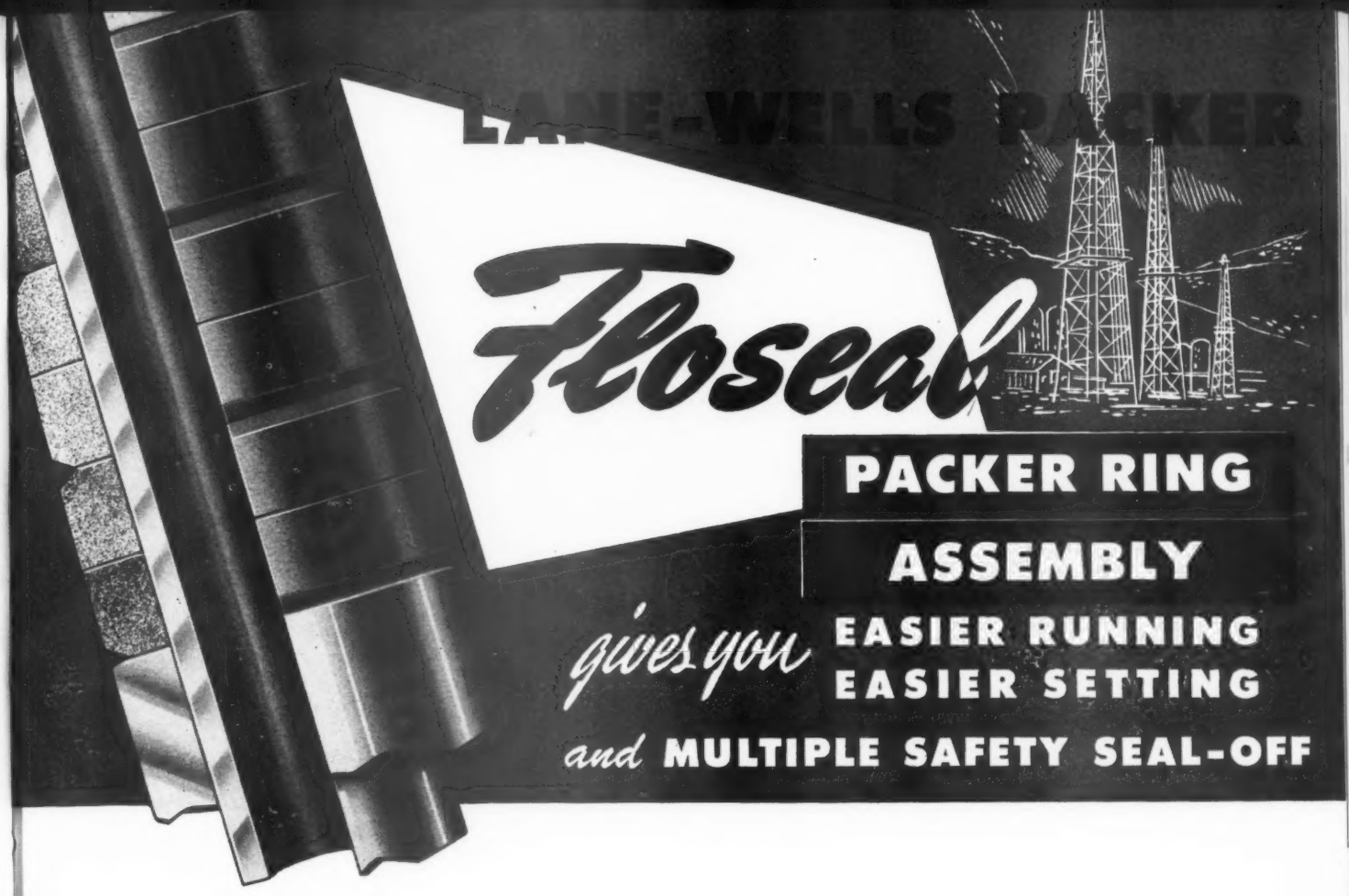
(6). Cost of remedial measures necessary for restoration of productivity in plugged gravel packed and prepacked wells will be no greater than the redrilling cost to be expected with conventional liners.

(7). Control of sand production through control of flow into the well has not been successful. Successful application would involve such low rates of production as to make it impractical under competitive conditions.

● **References.**

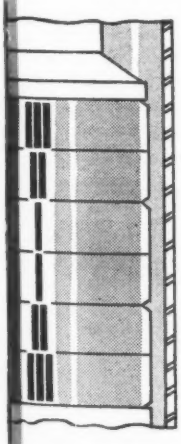
1. "Drilling and Production Problems in the Wilmington Field," C. J. Dean, *API Drilling and Production Practice*, 1938.
2. "Prepacked Gravel Liners," C. J. Coberly and E. M. Wagner, circular prepared under name of "Kobe."
3. "A Study of Some Factors Affecting the Screening of Unconsolidated Sands by Gravel in Wells" K. E. Hill. Thesis for master of science in petroleum engineering, University of California (1940).
4. "Screening Effect of Gravel on Unconsolidated Sands," B. Gumperts, *AIME Tech. Pub. No. 1195*, May, 1940.
5. "Some Considerations in the Selection and Installation of Gravel Pack in Oil Wells," C. J. Coberly and E. M. Wagner, *AIME Tech. Pub. No. 960*, August, 1938.
6. "Application of Gravel Packing to Unconsolidated Sands," Read Winterburn, *Oil Weekly*, January 11 and 18, 1943.

★ ★ ★



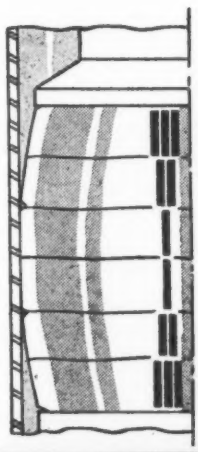
The Floseal Packer Ring Assembly — finest development since the invention of Multiple Ring Packers — is one of the "reasons why" Lane-Wells Packers stand up under the toughest conditions and give you far longer, trouble-free operating life in ordinary service.

FLOSEAL FLAT SIDES RELAX RUNNING IN!



Floseal Graded Rings — are assembled in integrated sets. As the packer is set, the inner rings expand first, confined by the outer rings. With more weight the outer rings take up the load to give a perfect pack-off every time. This is why Lane-Wells Packers seal-off at 12,000 feet as easily as they do at 3500 feet. Floseal Rings provide a tested pack-off against differential pressures up to 7,000 p.s.i. at temperatures of 300° F.

Whatever your packer application, there is a Lane-Wells Packer, designed and built to do the job better!



Tomorrow's Tools—Today!

Consult your Composite Catalog, pages 1999-2020 or call your nearest Lane-Wells Branch.

LANE-WELLS

TECHNICAL OILFIELD SERVICES

Los Angeles · Houston · Oklahoma City

5610 S. Soto St., Los Angeles 11, California

22 BRANCHES

GE's first chemical plant on the West Coast, which will manufacture alkyd resins, used for surface coatings.

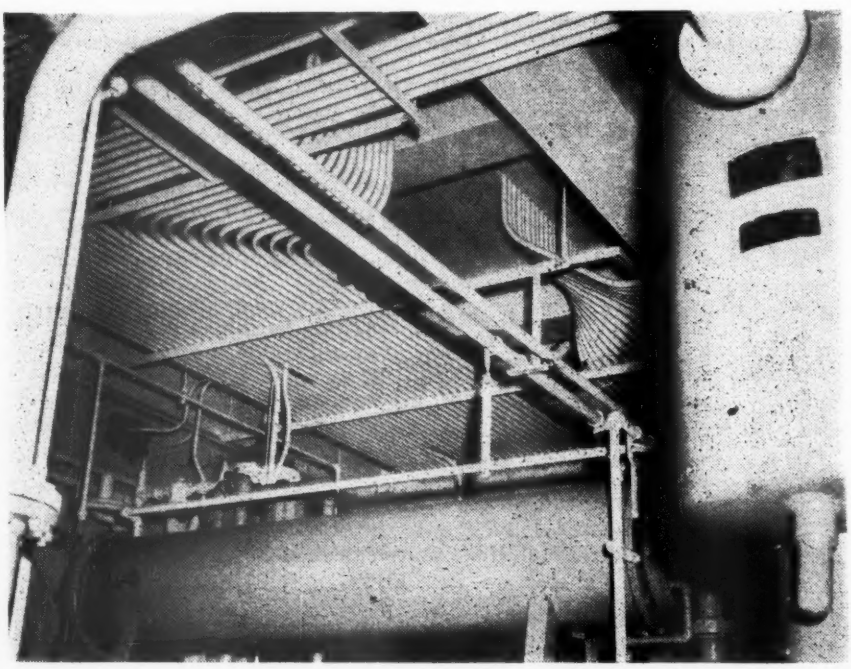
New plant to manufacture alkyd resins

JUST completed on May 21, for General Electric Company, and now in operation at Anaheim, California, is a new plant for the manufacture of Glyptal alkyd resins, used largely at the present time for surface coatings with a wide range of industrial applications, and with prospective uses that can only be vaguely guessed. The Glyptal resins, like many another such discovery, are the result of a long sustained search for a much needed product for private use—in this instance, for an insulating material that would withstand the assault of oil and other deleterious influences, and give longer life and better performance to electric motors.

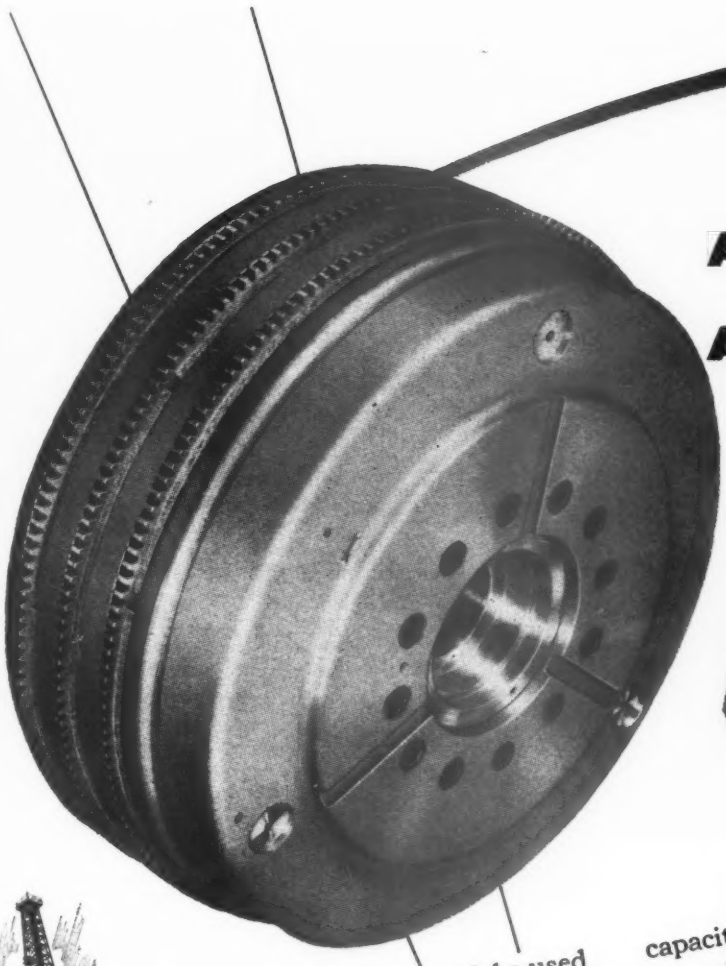
With the eventual development of the new product as a protective for motor windings and other essential components of the diverse electrical equipment, manufactured by the company, it was quickly found that it had many uses in other industries. Hence, the Pacific Coast plant—a strictly new departure in western enterprises, and a decided asset to the town of Anaheim and its environs. This is GE's ninth unit in the Pacific area, and the first chemical plant to be built here.

The entire plant was engineered and

Electrical conduit system in compressor room, shows atmosphere converters, two horizontal parallel tubes, that mix air and natural gas to make inert gas.



A NEW AIR-ACTUATED CLUTCH



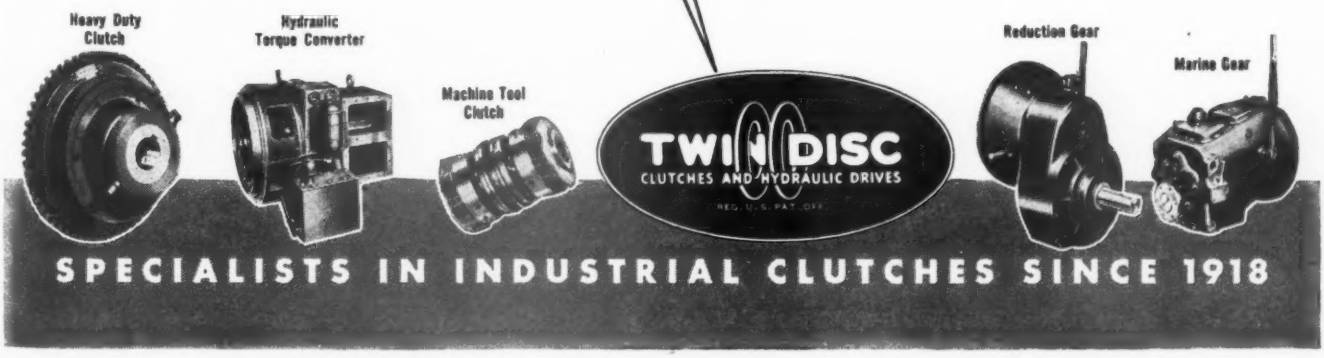
Supplementing the widely-used line of Twin Disc Model P Air-actuated Clutches, the *new* Model PH Clutch is the ideal unit for transmitting power to drum drives, and to other oil field machinery, where high torque must be delivered at low speeds.

The Model PH Clutch is built in 42″ size, with two- and three-plate construction. The three-plate model, having a high working torque capacity of 89,550 foot-pounds, is particularly suited to operating speeds well below 100 rpm. Maximum capacity is 1325 hp.

In addition to these advantages of size and capacity, the Model PH Clutch offers you the proved performance characteristics of the Model P Clutch, including high resistance to heat deterioration . . . rugged construction and simple design, assuring minimum maintenance and long wear-life . . . elimination of lubrication problems . . . and automatic adjustment of the clutch plates for friction wear.

Write the Twin Disc Clutch Company, Racine, Wisc., for the new Bulletin No. 139A which contains information on the complete line of Air-actuated Clutches. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

The new Twin Disc Model PH Clutch; size 42″ with three plates.



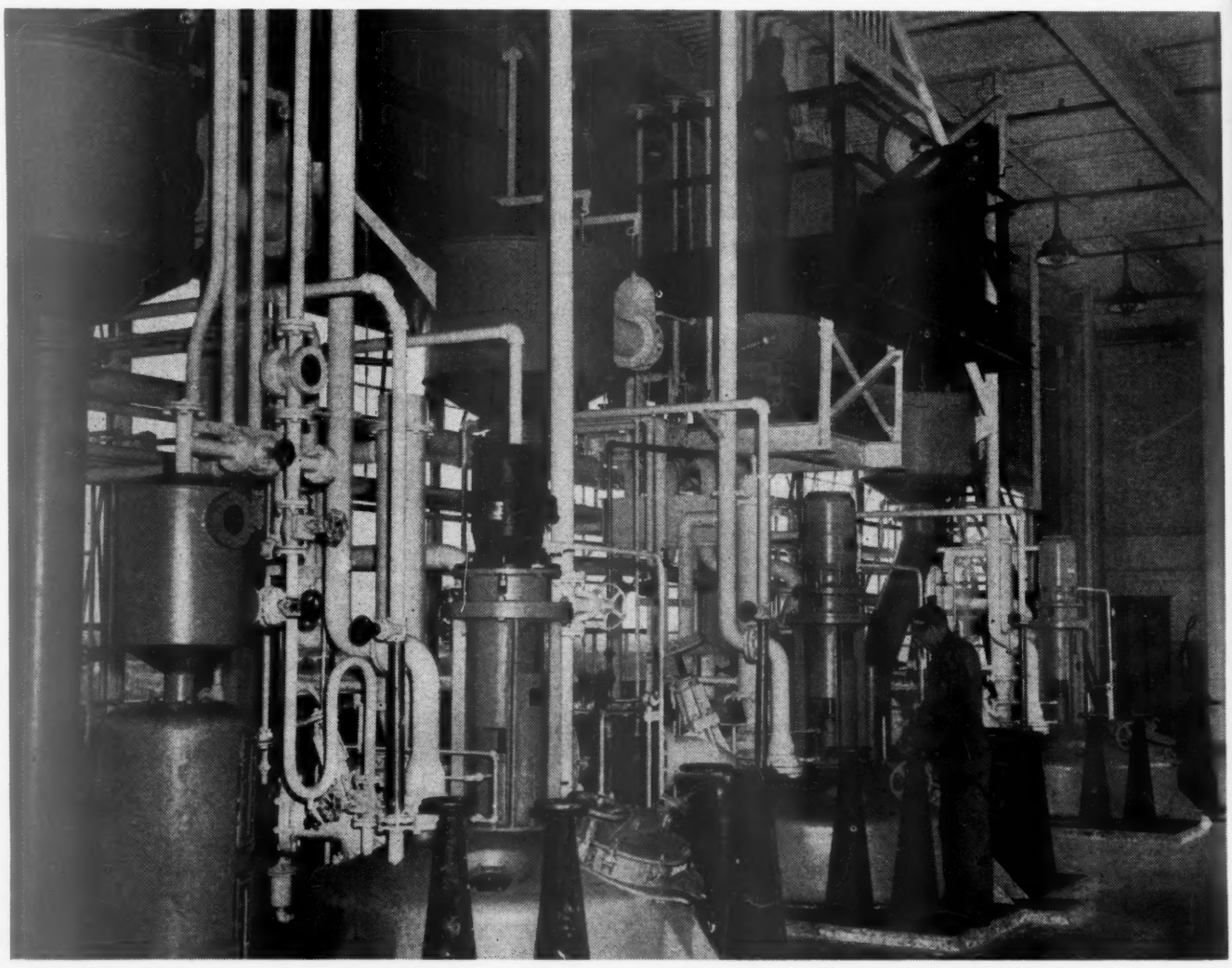
SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

constructed by the chemical division of Blaw-Knox Company, Pittsburgh, Pennsylvania, and is a thoroughly modern adaptation of chemical processing to large scale commercial operation. The various steps involved in the process include storage and handling of raw materials; measurement of liquid and solid ingredients; high temperature esterification and condensation reactions; dilution with appropriate thinners; clarification by filtration, and final product blending.

The Anaheim works are built on a level six-acre site and contain six buildings, tank farm, railroad trackage, roads, cooling tower, deep well water supply, and fire protection facilities. Natural gas is used exclusively for fuel. The offices and laboratory are air-conditioned throughout. Buildings are constructed of reinforced concrete footings, and floors, structural steel framing with transite and brick walls and metal roof decking covered with a built-up roof. All structural steel for the building and equipment is designed to resist earthquakes and is of welded construction.

Essentially, Glyptal alkyd resins are

Harvey Keel, left above, construction superintendent for Blaw-Knox; Claude Schutter, resident engineer for GE Realty, and L. L. Jones, superintendent of GE plant, are the three responsible for construction of the plant. Below, control floor for process kettles shows kettle tops, agitator drive, and attendant, M. T. Meeks, operating valves of heating system. L. S. Berg is on liquid raw materials weigh scale in the gallery. Sight glass port shows in center of left kettle top; extreme right, solids weigh tank.



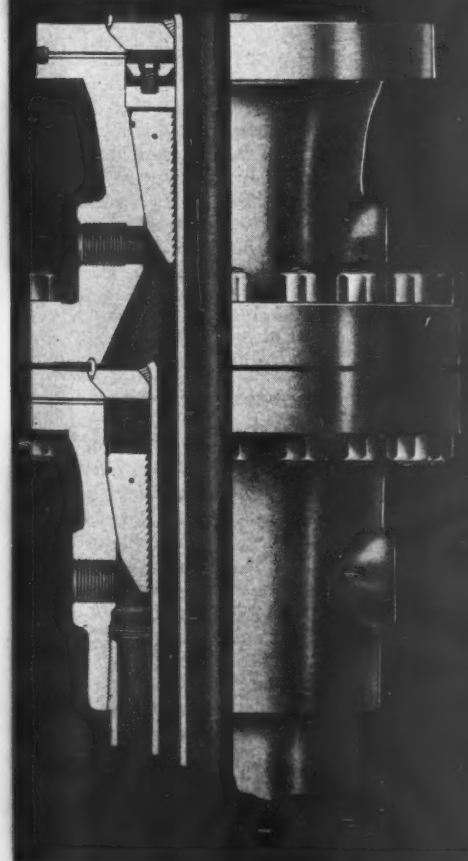
PROBLEM

To make safe, permanent seals in Refineries; Natural Gas and Gasoline Plants; Butane-Propane Plants; Pipe Lines; Chemical Plants.

SOLUTION:

Welding

And in RECTORHEADS! *too...*



WE ARE applying to well heads what operators in other branches of the industry learned long ago; namely, welded seals are unsurpassed for safety and permanence.

The RECTORHEAD welded casing head seal is made quickly and easily. The patented floating welding ring (much smaller than the conventional bulky welding flange) is easily heated at the same rate as the pipe. No strain or distortion is applied to ring or weld, during or after welding. STRESS RELIEVING IS NOT REQUIRED.

RECTORHEAD welding casing head seal has no resilient packing. It is a seal that will not deteriorate; will not burn out in case of fire; will not disintegrate under the action of anti-corrosive chemicals being used in so many wells. The permanent, leak-proof safety of RECTORHEADS prevents pressure equalization; eliminates the costly job of replacing well head packing; permanently protects your well investment.

Be safe! . . . Specify RECTORHEADS on all your wells.

RECTOR WELL EQUIPMENT CO., Inc.

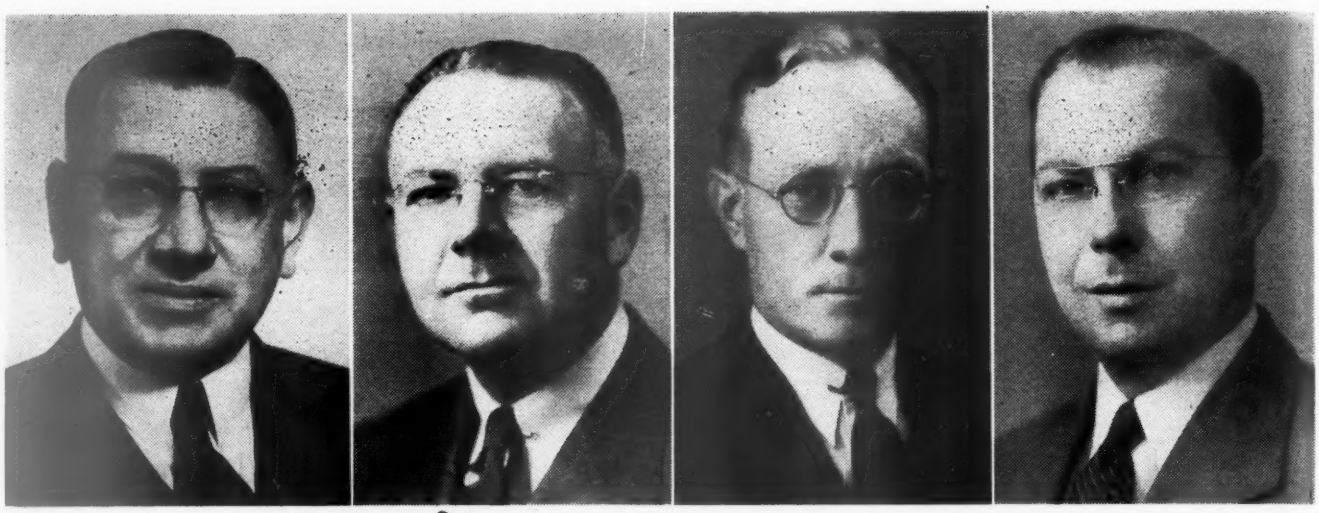
FORT WORTH NATIONAL BANK BUILDING, FORT WORTH, TEXAS

PLANTS: Fort Worth & Houston, Texas
Representatives in All Active Fields
Export: Lucey Export Corp., Woolworth Bldg., N. Y. C.

RECTOR

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

MAKING THE OIL INDUSTRY SAFER!



R. M. Alvord, GE commercial vice president, San Francisco. H. K. Collins, manager resin-insulation materials division. L. S. Ferguson, engineering manager of the division. L. L. Jones, superintendent, Anaheim Works, California.

synthetics in which are combined properties subtracted through chemistry from various materials produced in nature. Coal, petroleum, and animal and vegetable fats are the principal natural products used in the synthesis. Specifically, the compounds employed are phthalic anhydride, derived from coal or petroleum; glycerine from animal fats, and oil—soya, castor, or linseed. There are many different Glyptal alkyd resins, but they are all made from varying combinations of these raw materials. They are generally diluted by solvents and then form bases in which industrial users incorporate other ingredients to manufacture paints, insulation, etc.

The plant equipment consists in the main of storage capacity for both the raw and refined products; a transfer pump house for unloading and transferring fluid materials; weigh tanks for measuring both liquid and solid materials; treating kettles, wherein the ingredients are agitated and held at the desired temperature and pressure for the proper length of time; thinning tanks in which the resins are diluted; filter presses in which they are clarified, and a distributing system by means of which the finished product can be weighed into drums, loaded into railroad tankcars or tank trucks, or carried out into storage.

Berg operates control chains to select valves in lines to storage tanks.

It is interesting that Dowtherm, an organic heat-transfer fluid, is both the heating and cooling medium for the processing kettles. Compressed inert gas is used to control the manufacturing process. An electric eye assures correct weight in the drum-filling department. A floor ventilating system provides for the elimination of heavier-than-air fumes, and indeed, every precaution is exercised to obviate every foreseeable inaccuracy in the process, and every condition that might endanger the operators.

For storage of liquid raw materials, the total plant capacity is 150,000 gal. The liquid weigh tank handles 1000 gal at a time, and the solids weigh tank, 60 cu ft (or 600 gal, approximately). There are at present installed and in operation two 1500-gal treating kettles. There are four 3000-gal thinning tanks, and four filter presses capable of clarifying 35 gpm at 125 psi. Total storage for finished products is about 83,000 gal. Included in the assembly, also, are a boiler house with two marine-style boilers for generating the steam necessary for the process, an outdoor substation, and a modern laboratory for process control.

The new plant will, when in full production, employ about 60 people. It is under the management of L. L. Jones, industrial chemist and graduate of Colgate University, who has been with GE since 1928. It is one of the first postwar plants to be devoted exclusively to the development of surface coating resins, and its major output will be sold independently by Paul W. Wood of San Francisco, California, and J. E. Russell Company, Houston, Texas. ★★★

Formation logging

By RICHARD E. GILE, Rotary Engineering Company

EXCLUSIVE

FIELD superintendents, geologists, and engineers responsible for the drilling of exploratory wells need the best tools and techniques available to assure adequate testing of each prospective producing zone in every well drilled under their supervision. Management must be certain that the producing possibilities of each pay zone are properly evaluated and that no potential producing zone is overlooked in any exploratory well drilled by their organization. The need for improved technique becomes greater with increased depth of exploratory wells and with the resultant increase in cost of adequate testing procedures for accurate appraisal of each show of gas or oil.

Experience has established that gaseous hydrocarbons are generally present in the upper portion of each pay zone, whether the bit penetrates a free gas reservoir, a gas cap overlying a crude reservoir, a condensate reservoir, or even an undersaturated crude oil reservoir. When live hydrocarbon reservoirs are penetrated, gas in varying amounts is present. A new type of qualitative well logging of formations provides a mechanical means of detecting small amounts of gaseous hydrocarbons from samples of the formations taken immediately after the prospective pay zone is penetrated by the drill.

Experience has also established that fragments of subsurface formations drilled by the bit and returned to the surface in the drilling medium retain their essential characteristics of lithology, porosity, and permeability. Formation samples at atmospheric pressure also retain small but measurable quantities of gas, oil, or water, which are representative of the fluids contained in the formations under subsurface conditions. Hence, careful analysis of formation samples continuously as the well is drilled, by means of suitable equipment for the detection and measurement of small amounts of gas, oil, and water, provides a positive determination of the presence or absence of hydrocarbons in each foot of hole drilled in an exploratory well.

A recent development in the technique of well logging involves the application of vacuum to the formation samples to establish a pressure differential sufficient to release the contained residual gaseous hydrocarbons. Suitable solvents are applied to the formation samples to release the contained residual liquid hydrocarbons. Determination of hydrocarbon content, microscopic examination of lithology and porosity, record of drilling rate, correlation of formation samples with depth drilled, titration of solubles in the drilling fluid filtrate, and routine mud tests are made with specially built equipment. The equipment is mounted in a "logging" trailer stationed at the well and is operated on a continuous 24 hr daily basis by a specially trained crew of three engineers.

The well logging trailer is set up at the well near the fluid discharge line. Electric and water lines are connected, and two-way telephone communication between trailer and derrick floor is established. A wire line is attached to the swivel, thence to a weighted sheave on the derrick floor, thence over a second sheave on the derrick to a drum mechanism in the trailer that operates the depth meter and records depth and drilling rate. An electric alarm system notifies the engineer as each interval of hole is drilled, automatically measuring drilling rate and time interval for removing the formation sample from the fluid discharge line.

Computation of the time consumed in the travel of the formation samples from the bottom of the hole to the surface is made at frequent intervals by placing small brick chips in the fluid stream in the open end of the drill pipe when drill pipe connections are made and checking the total time for the round trip from the surface to the bottom of the hole and back to the surface. From this total time, the proper correction for pump displacement and internal capac-

FIG. 2

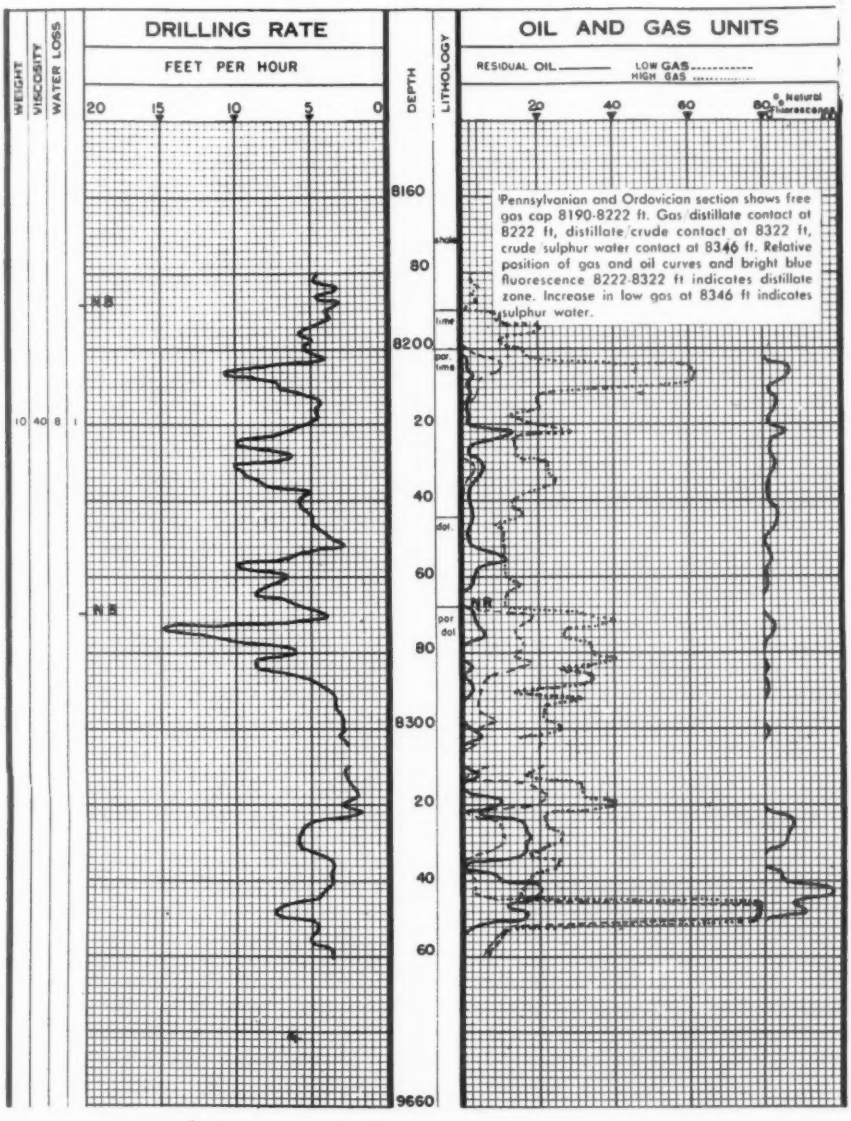
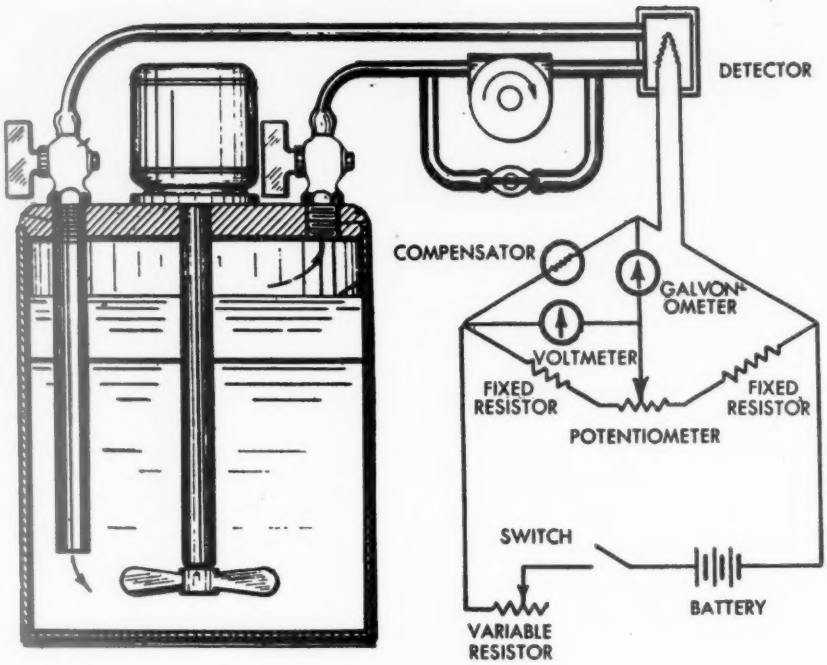

DRILLING RATE
FEET PER HOUR
20 15 10 5 0
WEIGHT
VISCOSITY
WATER LOSS
DEPTH
LITHOLOGY
OIL AND GAS UNITS
RESIDUAL OIL
LOW GAS
HIGH GAS
20 40 60 80
% Natural fluorescence
Pennsylvanian and Ordovician section shows free gas cap 8190-8222 ft. Gas distillate contact at 8222 ft, distillate crude contact at 8322 ft, crude sulphur water contact at 8346 ft. Relative position of gas and oil curves and bright blue fluorescence 8222-8322 ft indicates distillate zone. Increase in low gas at 8346 ft indicates sulphur water.
8160
8200
8300
9660

FIG. 1



ity of the drill pipe at the current drilling depth is subtracted.

The engineer collects the formation sample every two feet at the predetermined time lag interval, washes off excess drilling fluids, seals the sample in the container, and places it in a gas analyzer. The gas analyzer consists of the sample container, a vacuum pump, an agitator, and a Wheatstone bridge. The Wheatstone bridge is an electrical balance, in this particular application comprising detector and compensator filaments, fixed resistances, voltage control, potentiometer to establish balance, battery, switch, and recording galvanometer to measure variations in resistance in the detector circuit under varying conditions caused by ignition of hydrocarbon gases.

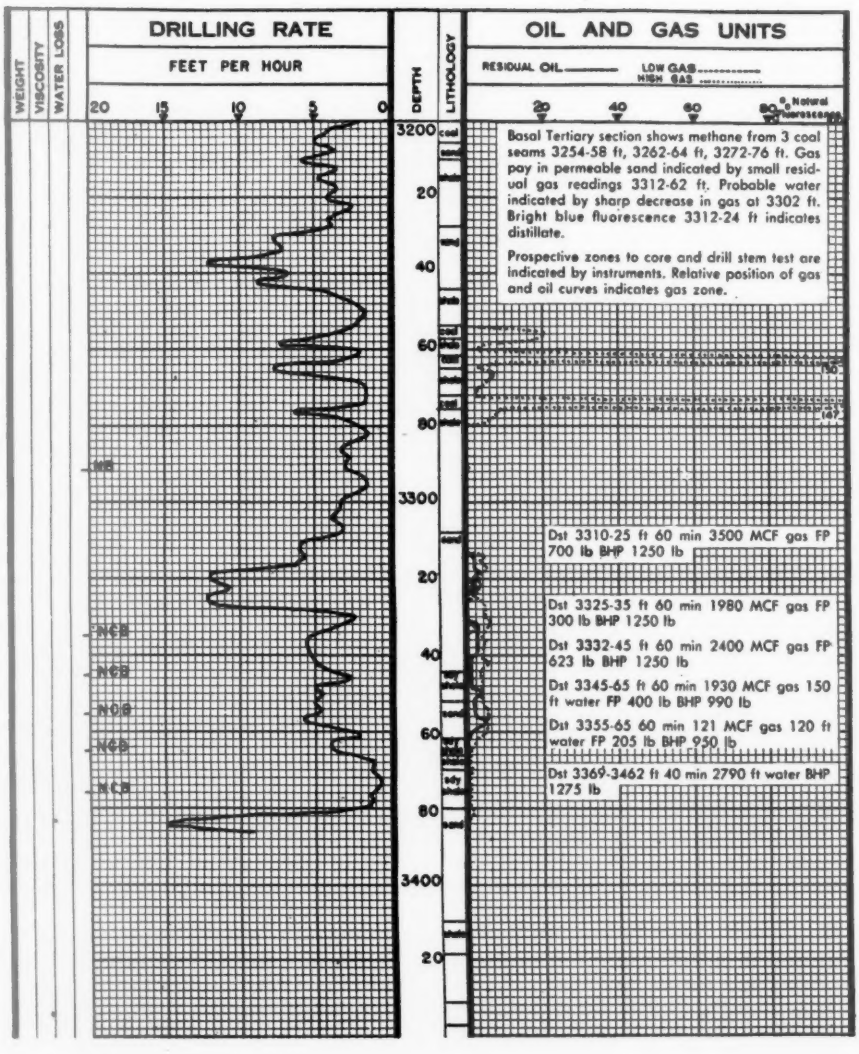
Prior to analyzation of the formation sample for gas content, the current is turned on and air is circulated across the detector filament and the galvanometer is adjusted to zero by the balancing potentiometer. Thus, the voltage of arm 1 in Fig. 1 is to the voltage of arm 2 as the voltage of arm 3 is to the voltage of arm 4, the bridge is in balance, and no current passes through the galvanometer. The formation sample to be analyzed is agitated so that each particle successively comes to the water-air interface in the container, where it is subjected to differential pressure to release the residual hydrocarbon gases. When the formation sample contains gas, the gas in pumped across the detector filament and ignited, thus creating additional resistance in the detector. This results in an imbalance of the bridge and a flow of current across the galvanometer, where the flow of current and the amount of gas are measured. If no gas is present in the formation sample, no flow is recorded

Each hydrocarbon gas has its distinctive characteristics: Ignition temperature, upper and lower explosive limits, boiling and freezing points, and specific gravity. The ignition temperature of the gas is the characteristic utilized in its detection by the Wheatstone bridge. Methane ignites at approximately 998 F and ethane at approximately 960 F, these being the so-called dry gases, with ignition points higher than those of the wet gases. Propane, pentane, hexane, heptane, butane, and the other so-called wet gases ignite at temperatures between 588 F and 870 F.

The temperature of the detector filament is controlled by a rheostat (voltage control.) By operating the Wheatstone bridge at various temperatures, a determination is made of the kind of residual gas in the formation samples. The amount of residual hydrocarbon gas in the sample determines the reading of the galvanometer in milliamperes, and serves as a measure of the amount and kind of residual gas in the formation sample. As the readings are made at or below atmospheric pressure, only the residual gases are determined and the readings are qualitative and do not measure the amount of gas in the subsurface formation at reservoir pressure.

Sulphur water-oil contacts are indicated with the Wheatstone bridge. Hy-

FIG. 3


WEIGHT
VISCOSITY
WATER LOSS
DRILLING RATE
FEET PER HOUR
20
15
10
5
0
DEPTH
LITHOLOGY
OIL AND GAS UNITS
RESIDUAL OIL
LOW GAS
HIGH GAS
20
40
60
80
% Natural Fluorescence
3200
3300
3400
Basal Tertiary section shows methane from 3 coal seams 3254-58 ft, 3262-64 ft, 3272-76 ft. Gas pay in permeable sand indicated by small residual gas readings 3312-62 ft. Probable water indicated by sharp decrease in gas at 3302 ft. Bright blue fluorescence 3312-24 ft indicates distillate.
Prospective zones to core and drill stem test are indicated by instruments. Relative position of gas and oil curves indicates gas zone.
Dst 3310-25 ft 60 min 3500 MCF gas FP 700 lb BHP 1250 lb
Dst 3325-35 ft 60 min 1980 MCF gas FP 300 lb BHP 1250 lb
Dst 3332-45 ft 60 min 2400 MCF gas FP 623 lb BHP 1250 lb
Dst 3345-65 ft 60 min 1930 MCF gas 150 ft water FP 400 lb BHP 990 lb
Dst 3355-65 60 min 121 MCF gas 120 ft water FP 205 lb BHP 950 lb
Dst 3369-3462 ft 40 min 2790 ft water BHP 1275 lb

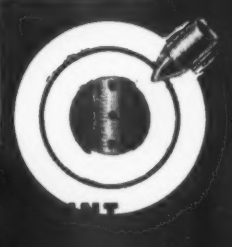
Still ANOTHER World's Record Gun Perforating Job...done by McCullough

5280 HOLES

shot between 7,000 and 8,000 ft. in just 58½ hours total time!

FOR THE SECOND TIME in five months, McCullough establishes a new world record for the greatest number of holes shot in one well at one time . . . 5280 holes shot with McCullough Burr-less Bullets through 7" O.D. 29 lb. N-80 casing, at depths between 7,000 and 8,000 feet, in the phenomenal time of just 58½ hours (including all rigging-up and tearing-down time). And, to indicate that even in the biggest jobs McCullough puts the shots where they count, *both* of the recent world's record jobs were done for the same company.

Such a tremendous number of holes shot in such an amazingly short time is made possible only by the special advantages which McCullough brings to *every* job . . . *simultaneous firing*, which not only gives you a perfect perforation pattern, but cuts down-the-hole time; *no electrical circuits in the gun* to cause delay between runs; *simplified equipment*, easier to rig up and tear down, saving you hours of rig time; *burr-less bullets*, eliminating the need for scraping the casing; *trained crews*, to give you fast, efficient service without dribbling away the minutes you pay for. That's why any McCullough job is money in your pocket.



McCullough PUTS THE SHOTS WHERE THEY

25 SERVICE LOCATIONS

McCULLOUGH TOOL COMPANY: 5820 S. Alameda St., Los Angeles 11, Calif.

TEXAS: HOUSTON, ALICE, CORPUS CHRISTI, McALLEN, ODESSA, TYLER, VICTORIA, WICHITA FALLS
OKLAHOMA: OKLAHOMA CITY, GUYMON, HEALDTON MISSISSIPPI: LAUREL NEW MEXICO: HOBBS
CALIFORNIA: LOS ANGELES, AVENAL, BAKERSFIELD, SACRAMENTO, VENTURA, SANTA MARIA
LOUISIANA: HOUMA, LAKE CHARLES, NEW IBERIA, SHREVEPORT KANSAS: ULYSSES WYOMING: CASPER

EXPORT OFFICE: 30 Rockefeller Plaza, New York 20, N. Y.

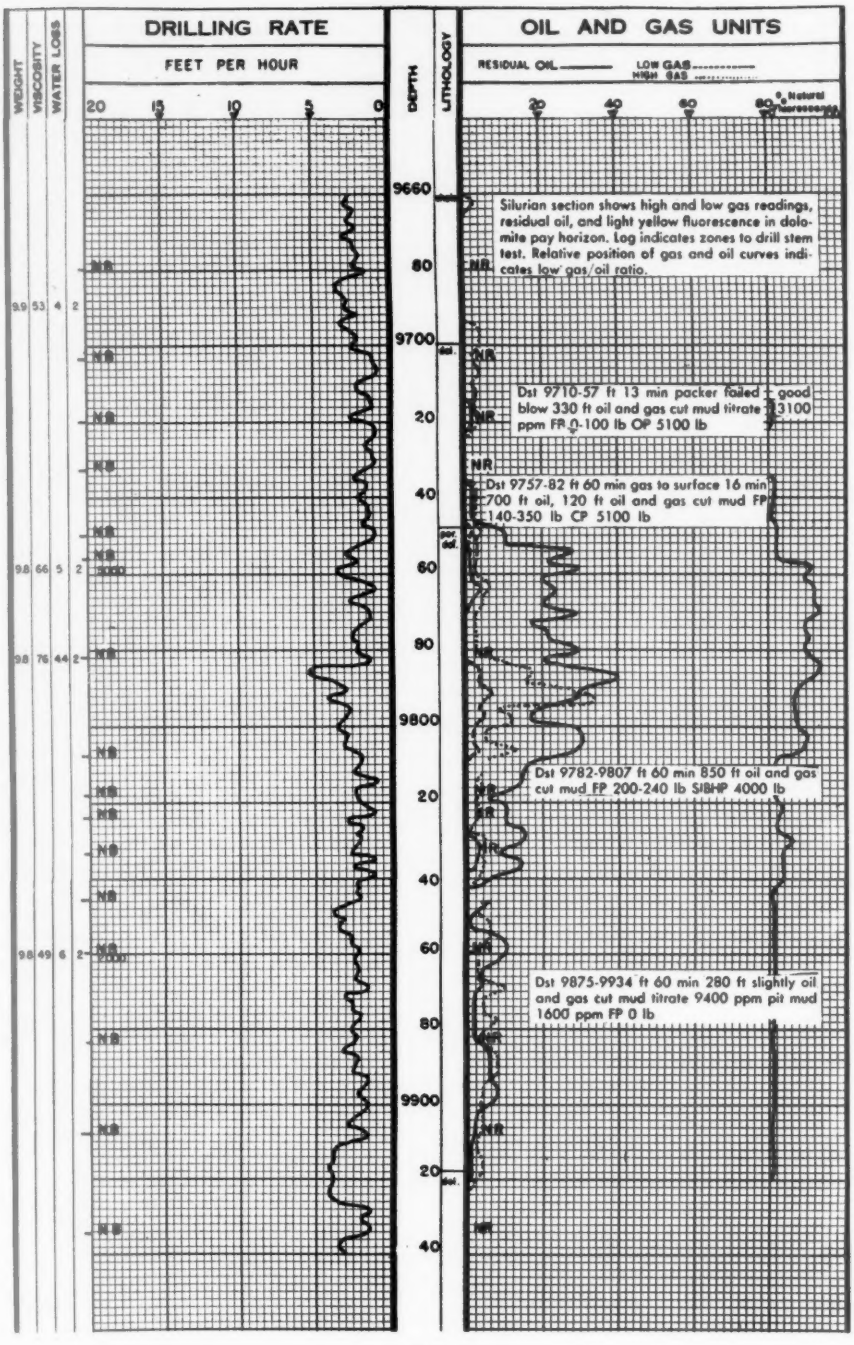

DRILLING RATE
FEET PER HOUR
20 15 10 5 0
WEIGHT
VISCOSITY
WATER LOSS
DEPTH
LITHOLOGY
OIL AND GAS UNITS
RESIDUAL OIL
LOW GAS
HIGH GAS
20 40 60 80 % Natural fluorescence
Silurian section shows high and low gas readings, residual oil, and light yellow fluorescence in dolomite pay horizon. Log indicates zones to drill stem test. Relative position of gas and oil curves indicates low gas/oil ratio.
Dst 9710-57 ft 13 min packer failed; good blow 330 ft oil and gas cut mud titrate 13100 ppm FP 0-100 lb OP 5100 lb
Dst 9757-82 ft 60 min gas to surface 16 min 700 ft oil, 120 ft oil and gas cut mud FP 140-350 lb CP 5100 lb
Dst 9782-9807 ft 60 min 850 ft oil and gas cut mud FP 200-240 lb SIBHP 4000 lb
Dst 9875-9934 ft 60 min 280 ft slightly oil and gas cut mud titrate 9400 ppm pit mud 1600 ppm FP 0 lb
9660
9700
9800
9900
NR

FIG. 4

drogen sulphide ignites at approximately 500 F, which is lower than the ignition points of most of the hydrocarbon gases normally associated with crude oils. Hydrogen sulphide gas is approximately four times as soluble in water as in crude oil. Consequently a marked increase in the amount of 500 F gas in the formation sample indicates the oil-sulphur water contact.

Reading across the Wheatstone bridge are made at four different temperatures: First at 1350 F, to insure that there are no inert gases that might distort the results (this reading is not recorded on the log); second at 1000 F, for a measure of total gas present (this reading is shown on the specimen log by the dotted curve); third at 870 F, to measure the wet gas present but not the dry gas (this reading is shown on the specimen log by the dashed curve; the difference between the dotted curve and the dashed curve shows the amount of dry gas in the sample), and fourth at 500 F, to ignite hydrocarbon sulphide for indication of sulphur water.

Each formation sample is examined under low-power magnification to determine the lithology of the formation drilled. High-power magnification is used for study of character and aggregate volume of porosity. Data are shown in the center section of the specimen log.

The formation sample is examined under 250-volt ultraviolet radiation with a special filter that permits passage of rays having a value of 3800 angstroms to determine the percentage fluorescence. A portion of the formation sample that shows natural fluorescence is segregated and placed in a compartment of a color reaction plate and treated with suitable solvents to leach the residual oil; the solvents used are miscible with crude oil in all proportions. After leaching the residual oil, the solvent is evaporated, leaving a residue on the color reaction plate. The residue is reexamined under ultraviolet radiation for determination of residual oil. Data are shown on the specimen log by the solid curve nearest the center index. The percentage natural fluorescence is shown by the solid curve at the extreme right of the specimen log, the index being at the fourth heavy line of the quad ruled section.

On the specimen logs, (Figs. 2, 3, and 4) data are plotted from determinations made by the logging engineers on a continuous 24-hr daily basis on three separate wells logged by this process. The first four columns at the extreme left show drilling mud characteristics, with figures for solubles in the drilling fluid filtrate. Drilling time in feet per hour is shown in the left quad ruled section. Depth and lithologic description are shown in the two center columns. In the right quad ruled section total gas is shown by the dotted curve, the dashed curve indicates wet gas, and the difference between the dashed and dotted curves shows the amount of dry gas. Leached residual oil is shown by the solid curve nearest the index. The percentage natural oil fluorescence is shown at the extreme right.

The determinations made by this type of logging service are qualitative only, and are not quantitative with respect to the amount of gas or oil producible from the subsurface formation. The primary purpose of qualitative logging is to locate every show of gas or oil with respect to actual bit depth in the reservoir formation while drilling progresses. It remains for the operator to appraise each show quantitatively. This may be done by taking cores at the points shown by qualitative logging to contain gas or oil, or by drillstem tests taken opposite zones that are shown by qualitative logging to be potentially productive.

This new technique of qualitative well logging for shows of gas and oil is employed on a continuous 24-hr daily basis on important exploratory wells for three principal purposes: (1) To insure that the operators' attention is called to every show of gas or oil as it is penetrated by the drill, so that no potentially productive zone will be overlooked; (2) to reduce substantially the total time involved in drilling and testing the well by limiting the slower and more expensive quantitative tests to those zones that are determined to contain gas or oil; (3) in the event the well is tested through casing perforations, to guide the spacing of perforations through the casing opposite oil pays, above water and below free gas, and thus to reduce the number of squeeze and re-perforation jobs.

★ ★ ★

For Dependable Leak-Proof Service

J&L CASING AND TUBING

Night or day, running a string of tubing is hard, fast work. Particularly at night your crews will find the precision threading of J&L Casing and Tubing helps them make up quickly. This feature assures you tight joints and long, dependable service.

J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH 30, PENNSYLVANIA

Diamond core drilling methods and problems

By CARROLL DEELY, Drilling and Service, Ltd.

EXCLUSIVE

THE first diamond core drill was developed by Rudolph Leschot in 1863. It was used to drill blast holes during the construction of the Mont Cenis Tunnel between France and Italy. About 1880 the diamond core drill was brought to the United States for use in the mining industry, where it became popular due to its efficiency and economy. Diamond core drilling equipment was improved gradually and became employed in the geological exploration phase of the petroleum industry. By 1930 almost every oil company had a diamond core drilling department for structural exploration. Today, this type of drilling has been replaced by various types of faster and more economical geophysical exploration.

In the early days of diamond coring, all diamond bits were hand set. This art was mastered by comparatively few people, and the driller often set his own bits. From four to eight Brazil carbonados were used in the hand set bits. These bits cut a core about 2-in. in diameter out of a 3-in. hole. The carbonados originally cost about $2.00 per carat, but as the demand increased the price gradually increased to a peak of about $200.00 per carat in 1929.

The continuous price increases seriously curtailed diamond drilling, and diamonds were used only when necessary to penetrate hard formations. As a result of the high price of carbons, the small bort bit was developed. This bit was set with approximately 150 stones instead of the four to eight carbons. The small bort was set by hand at first, but a mechanical setting method was developed by 1933 that considerably lowered the bit costs. At that time large quantities of the small bort were available, for there were few known uses except in small diamond tools.

● **Development of mechanical set diamond bits.** With the introduction of mechanical setting, the manufacture of bits developed along two lines: (1) A molten metal-casting process, and (2) a powdered-metal method. In the casting process the diamonds are placed in a mold and held in position either by suction or by a sticking medium, or both. The metal is then poured over them. The choice of metal for the matrix is somewhat limited in this process because the melting point has to be relatively low to prevent burning the diamonds, and there must be free flow of the matrix metal. The metals most commonly used are alloys of copper, aluminum, manganese, and nickel, principally beryllium-copper and aluminum, or manganese bronze.

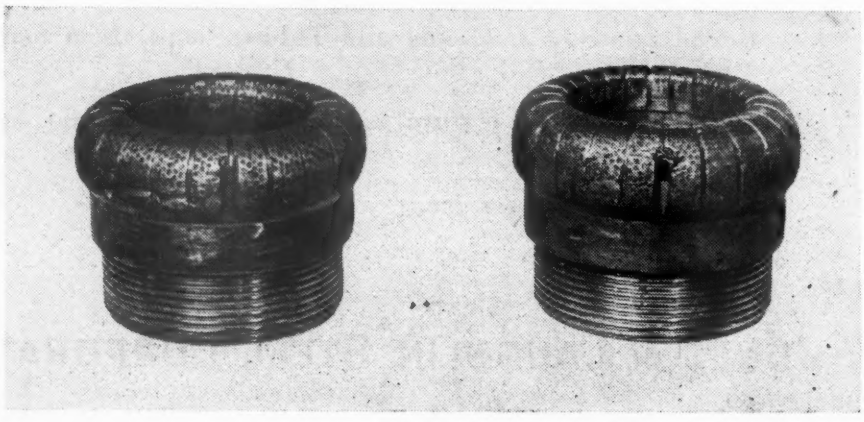
The powdered-metal method, which is now the more widely used, allows greater freedom of choice in the matter of matrix material. Tungsten cobalt nickel, copper, iron, aluminum, and molybdenum, among others, may be used to produce a more abrasion-resistant matrix. The diamonds are placed in a mold into which metal powder is pressed. The mass is then sintered together in a furnace that is carefully regulated. It is also possible to impregnate the powder with diamonds, resulting in a diamond-impregnated crown that can be used effectively in certain drilling operations.

● **Diamond core bits require careful drilling practices.** Much care is needed in the proper application of diamond bits to rock, particularly during the first few feet of drilling. Diamonds are brittle and require adequate support from the matrix. They will fracture easily under percussion, excessive vibration, or loss of matrix support due to abrasion or fluid erosion. They will also fail because of burning if proper circulation of drilling fluid is not maintained. The drilling fluid also plays an extremely important part in the operation by removing the sludge, or fine rock particles, as the bit penetrates the formation. If the volume of fluid across the face of the bit is insufficient, or the design of the bit is not adapted to the rock being drilled, the cuttings may not be removed freely. This results in the cuttings being ground up several times before being carried up the hole by the drilling fluid, and decreases drilling time while increasing diamond wear.

Other undesirable conditions are induced at the same time. Matrix wear is increased, thereby withdrawing some of the support given to the diamonds. Circulation passages may become blocked, so that an already bad condition is quickly made worse. Rapid deterioration of the diamonds and even burning of the matrix may result (see Fig. 1). These conditions are usually indicated by an appreciable increase in mud pump pressure.

Pressure or weight on the face of the bit while in operation and correct rotational speed are two other factors that materially affect the bit performance. Diamonds will withstand very heavy application of weight if they are adequately supported. The fact that diamonds do not shatter under such conditions, and that damage is not readily apparent to the eye, have caused the true effect of overloading to be overlooked. The effects are twofold. High pressure during rotation generates heat and this accelerates wear on the diamonds. It also forces the diamonds into the formation to a depth where they must take a heavier cut than they were originally designed to take, either by reason of their size or by the distance they protrude from the matrix. This sets up a heavy impact load that may cause breakdown. It also in-

FIG. 1. Small pieces of steel left on the bottom of the well in which these diamond bits were run caused the bits to fail. The groove on the inside lip of the left-hand bit interfered with the circulation of drilling fluid around the cutting face of core bit. This was indicated at the surface by a rapid increase in mud pump pressure and by failure of the bit to core ahead. The right-hand bit did not have a groove worn across the water courses but several diamonds were broken by the piece of steel that finally lodged in the outside lip of the bit.



Another BIG DEVELOPMENT

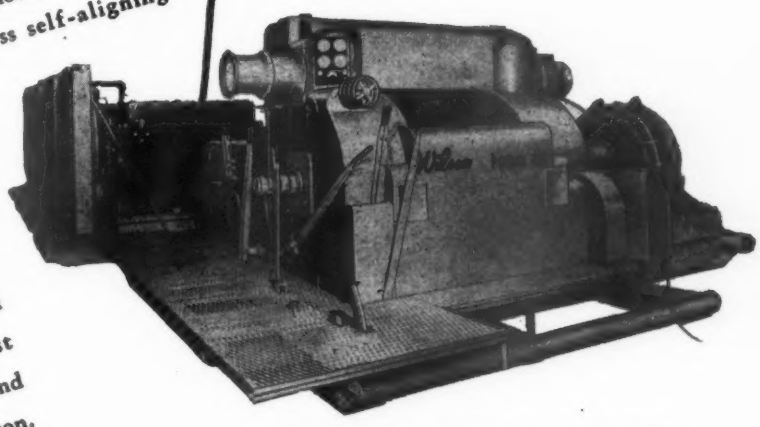
Wilson RIGS

ALL ANTI-FRICTION THROTTLE CONTROL

There's s-m-o-o-t-h-e-r operation with a Wilson Rig for friction in the throttle system has been reduced to an absolute minimum. On the hand wheel shaft, large precision roller bearings have replaced the bronze bushings . . . on all other shafts and bell cranks, needle bearings have been substituted for bronze bushings . . . the rods through the main skid have been increased in size and mounted on ball bearing sheaves . . . rust resisting frictionless self-aligning "rod ends" replace clevises and pins.

The foot throttle controls all engines and by pulling a pin in the rod system any engine can be disconnected.

Drillers that brag about the Throttle System, have acclaimed the new Wilson Line to be the best rigs ever made. See for yourself and then you too, will be sold on Wilson.



[WILSON RIGS AND WINCHES may be purchased from all recognized supply companies]

WILSON MANUFACTURING CO., INC. ● WICHITA FALLS, TEXAS

FIG. 2. Three pieces of a solid 16-ft core from the producing section of the San Andres lime formation in a 4700-ft well in West Texas.

creases the size and the volume of the cuttings, so that the water courses become inadequate. The same condition may prevail when the volume or velocity of the circulating fluid is insufficient. This results in the bit grinding its own cuttings several times before they are carried upward. The ill effects on the bit of this regrinding action have already been noted.

● **Rpm of diamond bit greatly affects coring speed and bit life.** The rotational speed of the bit determines the time interval between successive attacks upon the rock formation by the diamonds themselves. The correct rotational speed varies in different types of rock. It also varies with the amount of clearance of the diamonds over the matrix and with velocity of the drilling fluid. The correct speeds vary within well defined limits, however, for various sizes of bits.

When diamonds are forced into the formation and rotated they either break the bond holding the rock particles together or they cause a conchoidal fracture of the rock itself. The former action takes place in drilling sandstones, siltstones, shales, etc.; the latter action takes place in drilling chert, flint, or quartz. In either case a fragment of rock is loosened from the formation, and sufficient time must elapse for its removal before another fragment is loosened. This time interval is infinitesimal, but it is vitally important.

Two factors control the removal of cuttings: The size of the fragment with relation to the size of the passage designed for its removal, and the velocity of the drilling fluid that removes it. These factors are controlled by the size and projection of the diamonds; the weight on the cutting face of the bit; the design or pattern in which the diamonds are set; the arrangement of the water courses; the volume and velocity of the fluid passing over the face of the bit; and the rotational speed of the bit. This rpm of the bit must be such that the other controllable and fixed factors can work smoothly together.

There are two considerations in determining the correct rotational speed. The first is the fact that centrifugal force aids in moving the cuttings toward the periphery of the bit: This does not mean that a bit is self-cleaning, however, because the cuttings from the axial portion do not escape usually without being reground on the face of the bit while on their way to the periphery. Cuttings from the outside of the bit are removed more freely.

● **Diamond drilling first tried in Canada.** Diamond drilling was introduced about 1934 to the oil industry in Turner Valley field, Alberta, Canada. Other than for coring, this is the first application known to the author of the use of diamonds solely for hard rock drilling in oil wells. The results of this trial are unknown to the writer. In 1942, The Shell Oil Company made extensive diamond drilling experiments in some of their West Texas oil wells with somewhat encouraging results. Since that time, they have drilled with diamonds in other areas and have contributed to the development of diamond bits for drilling of oil wells. Ed. B. Williams, Jr., of Greenville, Texas, and The Wheel Trueing Tool Company of Detroit, Michigan, cooperated with Shell on bit designs and development.

The West Edmond field, Oklahoma, was drilled during the war at a fast rate and, due to the very low core recoveries from the Bois d'Arc oil producing section of the Hunton lime, very little information was available on the oil reserves or probable ultimate recovery. Early in 1945 Mr. R. E. Heithecker, then with the U. S. Bureau of Mines, initiated a move to use diamonds in an effort to obtain better core recoveries. As a result, the Sohio Petroleum Company engaged Drilling & Service, Ltd. of Dallas, to core the Bois d'Arc lime in their E. J. Lynch well No. 4. About 93 per cent of the core was recovered by the diamond core bit compared to less than 50 per cent recovery by other coring methods.[2] Soon afterward The Gulf Oil Corporation cored one of its West Edmond wells through the entire Hunton lime section and recovered 98 per cent of the core.

FIG. 3. Examining the San Andres lime cores after they were matched and laid out on the pipe rack walk. All the section cored was recovered in this instance. The cores are 3 in. in diameter.

After the successful West Edmond diamond coring, The Gulf Oil Corporation diamond cored one of its wells near Great Bend, Kansas, through the Arbuckle lime. A well near Eunice, New Mexico, was also cored by Gulf. The recoveries in both wells were high, and the cost was comparable with other methods, but following the coring of these four wells, diamond drilling was dormant for about one year so far as oil wells were concerned. Drilling & Service, Ltd. continued the use of diamonds, however, on their slim hole rigs in North Texas, South Texas, and Indiana at depths ranging from 1500 ft to 2500 ft with diamond bits developed by the Wheel Trueing Tool Company. In the latter part of 1946, core bits developed by this company were used in the Rangely, Colorado, field with notable effectiveness.[2]

● **Diamond coring tried in many areas since used at Rangely, Colorado.** Since Rangely, diamonds have been used in West Texas to core the San Andres lime and dolomite, the Drinkard lime, the Caddo lime, and Ellenburger lime; in Wyoming, the Ten Sleep Sand, the Frontier sections, and the Embar lime; in Alberta, Canada, at Turner Valley, the Madison lime; in East Texas, the Travis Peak; in the Anadarko Basin, Oklahoma, the Bromide section; in Kansas, the Arbuckle lime, and the Chase series.

Attempts to core the West Texas Devonian chert have been thwarted to some extent by the wedging and sticking of the core in the barrel. This is largely a core barrel problem, as the diamond bit effectively cuts the chert. The badly fractured pieces of the core wedge themselves in the barrel and prevent additional pieces of core from moving up into the receiving innertube. This jamming of the core in the barrel transfers weight from the bit to the top of the core in the barrel.

A diamond core bit is a precision tool that works on the grinding principle. It requires more care in handling, lighter weights, higher rotational speeds, and lower rates of fluid circulation than other core bits. For these reasons considerable difficulty has been encountered in adapting diamond core bits to the oilfield rig without using special equipment. It can be said, however, that good progress and results are being obtained despite these handicaps and diamond coring in most oil wells is a practical reality.

● **Diamond core bits act as grinders.** As just mentioned, diamonds work on the grinding principle and require certain lineal speeds to become effective. This fact is given consideration in designing a diamond core bit by keeping a maximum ratio between the core diameter and the hole diameter. If too small a core is cut, or no core is cut by using a solid bit, the outside diamonds may be rotated at the correct speed to cut that portion of the bit free. An overload will be put on the center diamonds, however, causing them to break down and damage the bit. Several solid bits have been run in oil wells, but the results to date have not been satisfactory due to pivoting of the center diamonds on hard rock.

Diamonds are fragile and very vulnerable to hard foreign objects left on the bottom of the hole, especially pieces of steel, iron, or hard rock core. Small pieces of core usually can be drilled up without serious damage to the diamonds. Pieces of steel or iron usually cause complete bit failure (see Fig. 1). Pieces of steel or iron present a serious problem for diamond bits in open-hole drilling. This is especially true where there are thick shale sections. Small pieces of steel or iron apparently lodge in cavities and mud cake on the sides of the hole and fall to the bottom as the core bits are run regardless of how clean the hole may have been at the beginning of diamond drilling.

In several open holes, the first cores were cut without any sign of "junk" metal, but on subsequent runs pieces of iron or steel had fallen in, and the diamond bits usually were damaged beyond further use. In other areas, such as parts of West Texas where the rock is harder and has fewer cavities and less mud cake, the hazard from metal lodged in the hole is not so great. In cased-hole, the metal hazard is usually eliminated completely. In such wells, diamond core bits have been found to be efficient and economical.

● **Diamond core bits have been used in deep wells.** Diamond core bits have been used effectively below 12,000 ft and in all formations encountered, including shale, lime, dolomite, sandstone, quartzite, conglomerate, etc. Diamonds appear to perform equally well with water or oil base drilling fluids.

In some areas, the use of diamond core bits has effected a saving in cost per ft of hole, and many days have been saved in completion time. In other areas, the cost per ft is comparable. The higher core recoveries, however, often warrant the use of diamonds. There is little doubt in the writer's opinion, that as the diamond drilling technique is developed and the crews become more familiar with diamond drilling, greater footages per bit will be realized. This will tend to lower the cost per foot.

At present, The Wheel Trueing Tool Company is conducting extensive research on bit design and metals for the matrix that will be more effective under the conditions encountered in the oil field. It is hoped that they will be able to offer the oil drilling industry a more durable bit in the near future.

Acknowledgement and credit should be given the oil companies who have contributed generously to the advancement and use of diamonds, in the order that they began to use them: Shell Oil Company, Sohio Petroleum Company, Gulf Oil Corporation, Stanolind Oil and Gas Company, The Texas Company, The California Company, Humble Oil and Refining Company, Mountain Fuel Supply Company, General Petroleum Company, Ohio Oil Company, Cities Service Oil Company, Phillips Petroleum Company, Atlantic Refining Company, and Royalite Oil Company.

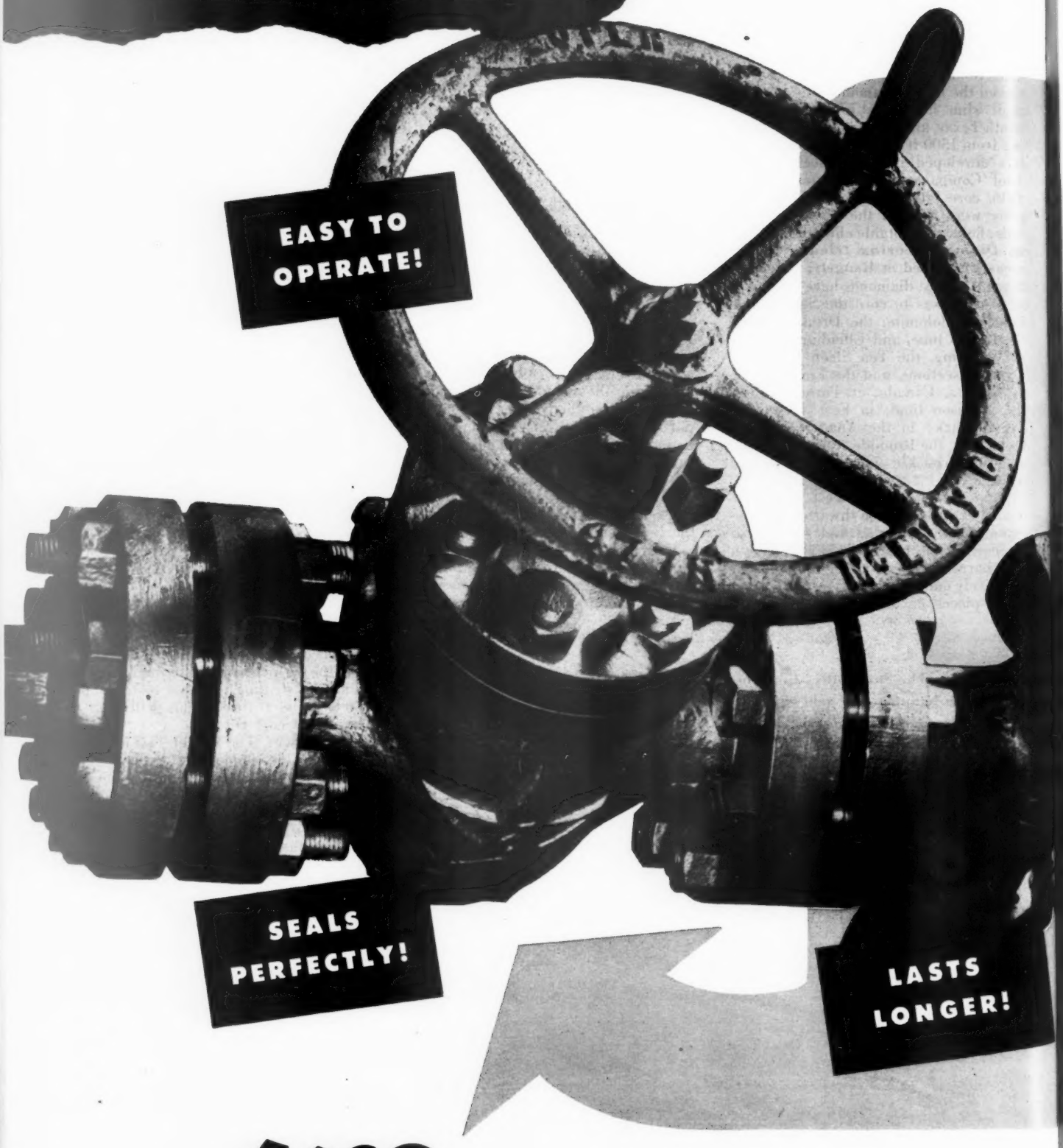
FIG. 4. The San Andres lime cores shown in Figs. 2 and 3 were broken with a hammer and cold chisel into 1-ft lengths by the geologist watching the well. Part of each length of core was canned for analysis at a core laboratory after this photo was taken. Remaining pieces were discarded with others that appear on the ground at right side of photograph.

● **References.**

1. "Diamond Bit Cores Hunton Lime Pay in West Edmond" by K. Marshall Ragin, *The Petroleum Engineer*, May, 1945, pages 237 to 240, inclusive.
2. "Diamond Coring at Rangely, Colorado" by Robert W. Stuart, *The Petroleum Engineer*, January, 1947, pages 43 to 48, inclusive.

★ ★ ★

A NEW KIND OF VALVE FOR
A NEW STANDARD OF SERVICE



EASY TO OPERATE!

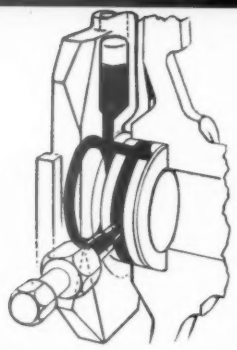
SEALS PERFECTLY!

LASTS LONGER!

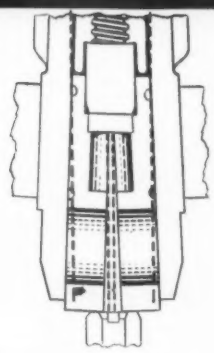
McEvoy COMPANY

TEXAS AT MILBY P. O. BOX 3127 HOUSTON 1, TEXAS

EXPORT SALES: E. F. Gahan, Inc., Room 1223, 500 Fifth Avenue, New York, N. Y.



AUTOMATIC LUBRICATION
Stands guard continuously—protects your valve by injecting lubricant *automatically* to stop any leak.



SELF ALIGNING GATES AND NON-DISTORTING SEATS
banish failures due to pressure and temperature distortion.

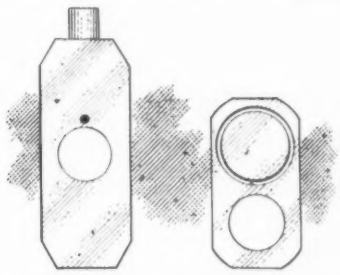
IT WORKS BETTER!

The McEvoy AUTOMATIC LUBRICATION CONDUIT GATE VALVE

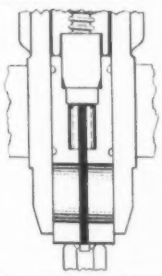
Ask your McEvoy Representative for full details on this revolutionary new valve. Ask him how it works, what it can do for you and what kind of service it has given others.

Then ask about the guarantee — find out how it protects you from loss.

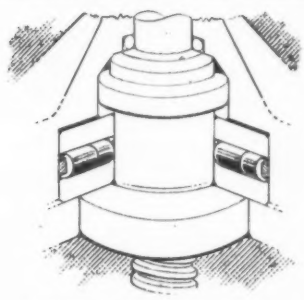
Then make up your own mind. We believe you will decide to join the ever growing list of satisfied users of McEvoy valves.



CHROME PLATED SEALING SURFACES
minimize friction — lengthen valve life — make operation easier.



NON-WEDGING DESIGN
eliminates "cheating" and consequent galling — makes valve easier to operate and helps prevent leaks.



ROLLER STEM-THRUST BEARING
makes valve operation even easier.

ONE YEAR GUARANTEE

McEvoy Lubricated Gate Valve is guaranteed to give satisfactory service; should, for any reason, McEvoy Lubricated Gate Valve fail to give satisfactory service during the period of one year from date of purchase, any repairs required will be made at Houston, Texas, free of cost, except transportation charges.

McEvoy Company shall not, however, be liable for any loss, injury or damage to any person or property, other than the valve, that may result from its use.

SOLD THROUGH ALL LEADING SUPPLY STORES

Developments in casing standards and design*

By JOHN WAIS, JR., Pittsburgh Steel Company

● **Abstract.** Important changes in casing standards and design have been proposed during the last five years, but were held in abeyance during the war emergency. Discussions at the 1946 Fall Meeting of the American Petroleum Institute indicated an increased field demand for the revisions, and preliminary developments on several subjects are discussed in this paper.

A proposal to increase casing thread standoff one turn was acted on favorably, subject to letter ballot. This change permits one more turn of makeup during the assembly of the couplings by the manufacturer as well as in running pipe in the field. Greater care will be required to develop this additional makeup without damaging the pipe or couplings either due to thread friction or crushing with tongs. Flattening combined with notching may cause serious reduction in bursting strength.

Coupling stresses due to makeup and internal pressure are additive according to analytical investigations, and the added makeup combined with high pressures result in values that should not be disregarded in designing for increased tensile and burst requirements.

Higher internal test pressures are being requested by users and more definite values for maximum test requirements are required to permit proper design of testing equipment.

Higher strength casing joints utilizing upsetting and various methods of treating to increase strength are being developed. Joint strength data for information purposes were approved for publication by the main Pipe Committee at the 1946 Fall API Meeting.

● **Introduction.** During the period from 1941 to the present, almost all proposals for revision of API pipe specifications have been held in abeyance due to the war emergency, while demands for changes resulting from new field requirements have accumulated. As a result, proposed changes that are now in the experimental stage or on the agenda of the Pipe Committee undoubtedly will aid in the solution of some of our more serious casing problems.

Intensive work on thread specifications during the last ten years has resulted in basic standards that are sufficient for normal requirements; however, in order to resist loads and pressures incidental to the drilling of wells to increasing depths, it has become evident that the necessary improvements cannot be accomplished by further changes in thread form or related specifications alone.

The primary objectives of the changes under consideration are:

1. More effective resistance to joint leakage at high pressures.
2. Higher joint strength.

Considerable progress toward accomplishing these objectives has already been made by laboratory developments and field tests on factors such as lubricants, makeup, and joint design.

These developments involve design, manufacturing, and field application, and some of them require additional information from users to permit final decisions. Accordingly, it is the purpose of this paper to review these proposals and developments and to discuss the field requirements that prompted them as well as field problems relating to their full utilization.

● **Thread makeup.** Thread makeup has long been recognized as one of the obvious factors affecting leakage; however, its importance became more evident when hydrostatic testing of threaded joints at internal pressures above 5000 psi was undertaken.

The former practice of using a nominal 2 or 2½ turn makeup from hand-tight, depending on the size, has resulted in satisfactory resistance to leakage at routine internal hydrostatic test pressures of 3000 psi maximum. Supplementary testing to pressures of 5000 to 7000 psi, however, showed leakers on the order of 25 per cent, as reported by Kettenburg and Schmieder[1].

It was found repeatedly by various experimenters that greater makeup almost invariably reduced this leakage or stopped it entirely. Also, it has been noted repeatedly that joint efficiency reaches an optimum value at slightly more than three turns makeup, and rarely shows any decrease due to excessive makeup until considerably past three turns. Thomas and Bartok[2] showed detailed results of numerous tests of the effect of makeup on both leak resistance and joint efficiency and their results have been checked very closely by several observers.

In recognition of these results the API Pipe Committee increased the hand-tight standoff by one turn, subject to letter ballot. The effect of this action is to allow for one more turn of makeup and it is up to the manufacturer when assembling couplings, and the casing crew when running pipe, to make up the joint the additional turn. To accomplish this will require considerably higher torque and much greater precaution to avoid damage to the pipe or coupling.

The problems incidental to greater makeup relate primarily to prevention of damage to threads and crushing of pipe. Greater care must be exercised in cleaning threads in order to eliminate all dirt and foreign material that might increase friction and the consequent tendency to gall.

Thread dope must have adequate lubricating properties to eliminate excessive friction under the high surface pressures incidental to the added makeup. The desirable properties of thread lubricants have been discussed at length in other papers but it will bear repeating that such lubricants must contain a sealing agent capable of closing the root and crest clearances as well as the permissible imperfections of the threads. Also, it must offer protection for the threads against corrosion before and after being run into the well.

Tongs must have gripping surfaces of proper size and shape to prevent flattening or notching the pipe. It has been recognized generally that any damage to the surface of pipe is detrimental, but its real significance became evident in laboratory tests prompted by field service burst failures occurring about one to two feet above collars, where tonging normally takes place.

● **Effect of notching and flattening.** Internal hydrostatic pressure tests were made on N-80 casing with various combinations of flattening and longitudinal notching. The theoretical effect of internal pressure on a flattened tube is to tend to round it out, causing an exaggerated tensile stress at the outside surface of the flattened area due to bending. This effect is further magnified by concentration at the root of any notch in the flattened area.

Test specimens were prepared in a compression testing machine to permit accurate dimensional control. Notching was performed with a single die 6 in. in length and ground to a sharp 60 deg edge. The fully flattened area was approximately 6 in. in length in all cases.

It was found that the critical combination is that of a longitudinal notch at or near the center of the flattened area. Notches alone up to depths of 12½ per cent of the wall thickness or flattening alone up to 3 per cent of the outside diameter had no perceptible effect on bursting strength. Notches alone, with depths of 12½ per cent to 16 per cent of the wall thickness, had very little effect on bursting pressures but failures did begin to localize at the notches.

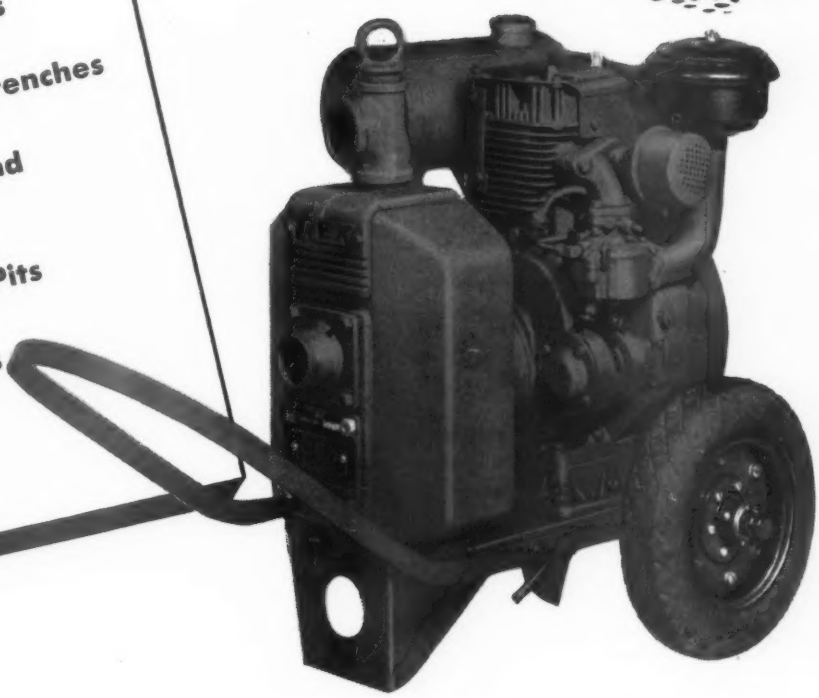
The critical combination of notching at the axis of the flattened area reduced bursting pressures as much as 70 per cent with notch depths of 15 to 17 per cent of the wall thickness and ovality of 3 to 4 per cent. It is recognized that these deformations are in excess of API

*Presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Los Angeles, California, May 15 and 16, 1947.

THERE'S A NEW LITTLE YELLOW PUMP —

Around the Producing Wells!

- Lifting Oil to Separators
- Dewatering Firewall Trenches
- Transferring Oil to and from Storage
- Salvaging Oil from Pits
- Filling Water Tanks
- General Utility Service

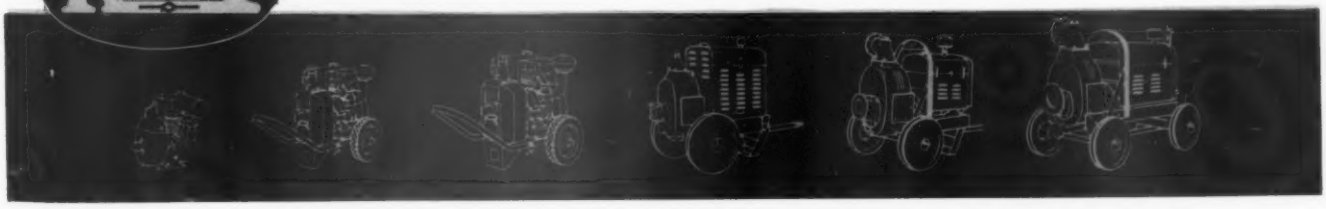


It's exceptional all-round pumping ability *plus* top portability that makes the *new* little yellow Rex Pump so popular in the fields. Just wheel it wherever you want to set it up, start the motor and forget it. It will keep right on pumping until the job is done.

With the new press-formed pump body and volute, the new Rex Pump is much lighter than old-fashioned cast pumps. And it's even more durable. The body won't crack or shatter under rough handling. It's built to give you a lot of dependable service. An important feature of the little yellow pump is its ability to handle vapors without losing its prime. The exclusive adjustable "air peeler" peels air or vapor from the impeller and rushes it out through the discharge, assuring a constant prime.

For all the facts on the new little Rex Pump, see your Rex Field Engineer, your local supply store, or write direct to Chain Belt Company, 1719 West Bruce Street, Milwaukee 4, Wis.

REX **OIL FIELD PUMPS**



CHAIN BELT COMPANY *of* MILWAUKEE

allowables, but their practical seriousness becomes more apparent when it is realized that 17 per cent of the wall thickness was only 0.054 in. and that 4 per cent of the outside diameter only amounted to 0.280 in. Specimens with lower yield strengths resulted in somewhat less sensitivity to the same degree of notching and ovality, but in all cases the reduction was serious enough to be alarming and to justify precautionary measures to avoid combined flat spots and notches in service.

● **High pressure testing.** Other important proposals before the API Pipe Committee are those pertaining to hydrostatic pressure testing. Production from deeper zones has led to a demand for internal hydrostatic testing to increasingly higher pressures. An increase of routine test pressure from 3000 to 3300 psi is under consideration and further information is being developed on this subject. Also, there is a proposal under consideration to have all casing tested to produce a fiber stress equal to 80 per cent of the specified minimum yield. It is agreed that hydrostatic testing for only five seconds, as now specified by API Pipe Standards, serves as a test for the quality of the material but not as an adequate test of joint tightness.

Both proposals have been passed on for further study due to the limitations of existing production line testing equipment and due to the scarcity and limited capacity of equipment capable of continuous operation in excess of 3000 psi.

Both proposals involve radical revisions or renewal of expensive testing equipment. Further information is required from users regarding maximum test pressures required, and time that test prssures are to be held. It is important that accurate and reasonable values be determined in order to obtain the proper economic balance between field requirements and the burden these revisions will impose on the pipe manufacturers.

A special subcommittee on hydrostatic mill tests has been appointed to collect and correlate information to aid in establishing ceiling pressures for both mill production tests and special mill tests, as well as the length of the testing period.

● **Coupling stresses.** The behavior of couplings under various types of loading has prompted analytical investigation of stresses under high internal pressures. At the outset, it is recognized that the result of any analysis depends on assumptions of conditions for which it is made. In this particular case there is a choice of varying combinations of internal pressure and longitudinal loading, and it is possible that to a certain degree longitudinal loads have the effect of reducing hoop tension due to internal pressure. Also there is the effect of thread flank angle toward expanding the coupling. In view of the complex nature of these secondary effects, which tend to offset each other, an approximate analysis is presented based on hoop stress alone.

The effect of making up a joint is to expand the coupling and compress the pipe, which is equivalent to pre-stressing the coupling in tension and the pipe in compression. Then the effect of added internal pressure is to superimpose an expansion on both, with the result that the hoop stresses in the coupling due to makeup and internal pressures are additive.

This condition is shown graphically on Figs. 1 and 2, which are based on strain proportional to makeup, starting from the hand-tight position. Actually, a fraction of a turn of power makeup is usually required to eliminate minor variations and bring the threads to "metal to metal" contact, where uniform increase of strain begins. For simplicity, these calculations have been based on coupling and pipe dimensions at the hand-tight plane. The coupling stresses are lower if calculated nearer the end of the pipe and higher if taken nearer the end of the coupling. The theoretical strain and the resulting stress due to makeup are proportioned between the pipe and coupling by the formula for total strain.[a]

The hoop stress due to internal pres-

a See Appendix 1.

FIG. 1. Average hoop stress at hand tight plane 7-in. by 29-lb casing with 7.656-in. OD coupling.

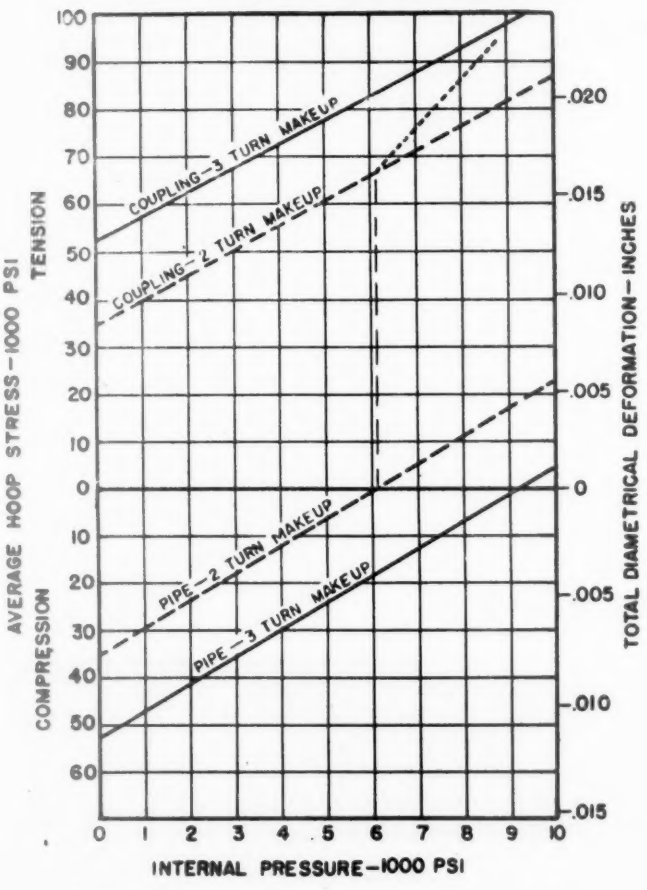
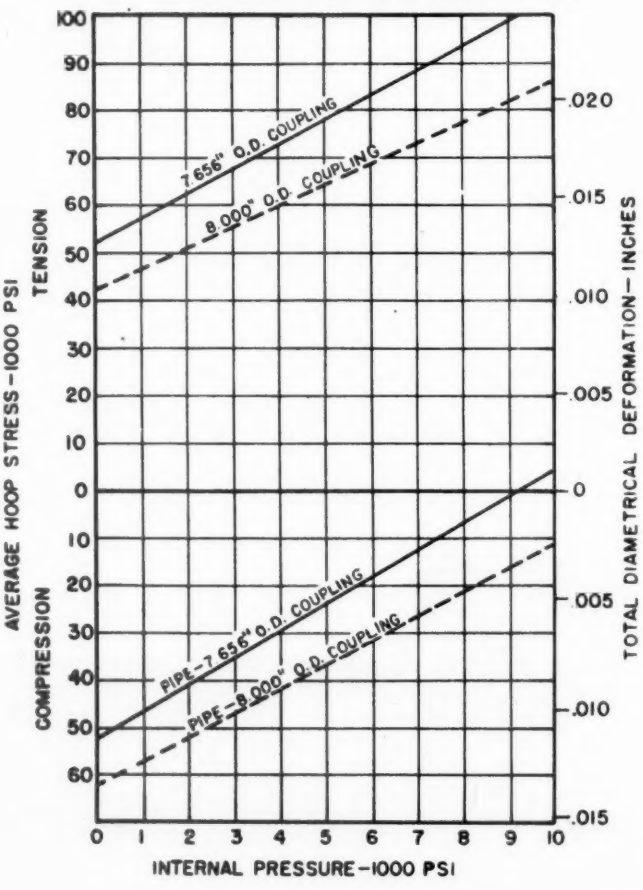


FIG. 2. Average hoop stress at hand tight plane 7-in. by 29-lb casing with three turn makeup.



sure is calculated by Barlow's formula[b]. It should be noted that the effective thickness in this application of the formula consists of the combined thickness of pipe and coupling. This is true as long as the two expand together, but tests with strain gauges indicate that after hoop compression stress in the pipe is relaxed, the coupling stress increases at a higher rate. The indications are that the pipe does not continue to act with the coupling beyond the point of zero stress in the pipe. Instead the pipe remains relaxed and fluid begins to enter between the pipe and coupling, resulting in all of the hoop load being applied to the coupling at further increased pressures. Such a condition is illustrated by the dotted line on Fig. 1, and can be compared with the pipe and coupling acting together as represented by the dashed line.

This may represent the mechanics by which a threaded joint resists leakage. As long as the pipe member is under hoop compression and the thread elements are properly matched, the joint can mechanically resist leakage. It is immediately evident that the higher the makeup stress or the heavier the coupling, the higher the pressure that will be required to exceed these conditions of joint tightness..

For external pressures the initial stresses are the same as for internal pressures; however, as the pressure is applied the tension in the coupling decreases and the compression in the pipe increases. Comparable additive stress values in collapse are generally not critical. This is due to the stress at collapse failure being below the yield strength.

Fig. 1 shows the calculated stresses for 7-in. by 29-lb casing with standard API 7.656-in. OD couplings with two and three turn makeup. Even if a half turn is allowed from hand-tight to complete metal to metal contact, it can be seen that with three turn makeup and 6000 psi. internal pressure, the hoop stress component alone is very near the minimum yield strength of N-80 couplings, disregarding the complex effect of accompanying longitudinal loads.

Fig. 2 shows the theoretical comparison of 7.656-in. OD and 8.000-in. OD couplings on 7-in. by 29-lb casing with three turn makeup. It is indicated that the 8.000-in. OD coupling would have considerably lower stresses, and would be comparable to the 7.656-in. OD with only two turns makeup.

The effect of these high hoop stresses has been noted in hydrostatic testing to high internal pressures. Couplings occasionally have been found loose after testing, indicating that some part of the threaded joint had exceeded the elastic limit. This was especially true of N-80 casing equipped with J-55 couplings.

It should be recognized that coupling stress relationships such as indicated by Figs. 1 and 2 are more favorable on lighter weights of casing. They are least favorable on 5½-in. and 7-in. casing due to the fact that coupling thicknesses for these two sizes are proportionally less than for the adjacent sizes.

These charts also show that under high internal pressures the total expansion on the diameter (Fig. 1) amounts to as much as 0.020 in. It is hardly conceivable that this much deformation could be developed without distorting the threads and adding to the tendency to leak. In future test work it appears advisable to investigate possible beneficial effects of reducing total deformation.

It is not the purpose of this paper to recommend a change in coupling dimensions, but the high stresses and strains incidental to high pressure applications indicate that in some instances it may be desirable to increase coupling thickness.

● **High strength casing joints.** The design of high strength joints has been receiving considerable attention from both users and manufacturers. Early developments were centered around the use of internal upsetting to compensate for the metal removed by threading. Later developments have included heat treating, cold working, and combinations of upsetting with the latter two. Conforming to these developments, the API reference to this class of product was changed from "Upset Joint" to "API High Strength Joint" at the 1946 Fall Meeting.

At the beginning the objective of this program was to develop a joint as strong as the body of the pipe, but subsequent field use has indicated that, particularly in the larger sizes, somewhat lower joint strength is sufficient and more practical from the standpoints of clearances and ease of manufacture.

A tabulation of joint strength data suitable for publication for informational purposes has been developed and approved by the API Pipe Committee. This list will serve as a working basis to aid in development of a final specification and therefore it is important that every prospective user examine it critically as soon as it is published.

For the present this program has been limited to four sizes—5½ in., 7 in., 8⅝ in., and 9⅝ in. These are listed in J-55 and N-80 grades with both short and long threads and in both upset and not upset treated types. Coupling dimensions remain the same but physical properties have not been specified, thereby permitting the use of any coupling physical properties that prove to be necessary to develop the desired joint strength. Pipe ends may be cold worked, heat treated, or otherwise processed to increase the physical properties of the steel at the joint, thus allowing as much leeway as possible for further development. The upset dimensions for each size casing have been set tentatively to permit passage of the drift specified for the corresponding size and weight of non-upset casing in order to minimize restriction at the joint.

☆ ☆ ☆

Although a well is believed to have been drilled to 5,575 feet in Pennsylvania in 1898, is was not until 1919 that the deepest producing field in the country was down to 5,400 feet.

Appendix 1

Derivation of average hoop stresses in pipe and couplings (disregarding effect of longitudinal loads).

Nomenclature:

l = circumference on centerline.
d = tangential total strain.
D = outside diameter.
P = tangential load (hoop load).
p = internal pressure, psi.
t = wall thickness.
A = area per unit length.
S = hoop stress.
E = modulus of elasticity.
Subscript "p" refers to pipe.
Subscript "c" refers to coupling.
Subscript "Tot" refers to sum of pipe and coupling values for the element involved.

Stresses due to makeup are based on the formula for total strain:

$$d = \frac{Pl}{AE}$$

and the assumption that makeup causes constant deformation of the pipe and coupling, such that:

$$d_c + d_p = d_{Tot} = (\text{taper per turn}) \times (\text{turns makeup}) \times \pi$$

$$d_c = \frac{P_c l_c}{A_c E} = \frac{P_c l_c}{t_c E}$$

$$d_p = \frac{P_p l_p}{A_p E} = \frac{P_p l_p}{t_p E}$$

$$P_c = P_p = \frac{d_c t_c E}{l_c} = \frac{d_p t_p E}{l_p}$$

$$d_c = \frac{d_p t_p E l_c}{l_p t_c E}$$

$$d_p = d_{Tot} - d_c$$

$$S_c = \frac{P_c}{A_c} \text{ (tension)}$$

$$S_p = \frac{P_p}{A_p} \text{ (compression)}$$

Assuming linear stress distribution across the wall thickness, average stress is correct within 5 per cent where the D/t of the section is on the order of 20 or higher.

Appendix 2

Stresses due to internal pressure are based on Barlow's formula.

Coupling:

$$S_c = \frac{pD_c}{2t_{Tot}}$$

Pipe:

$$S_p = \frac{S_c D_c}{D_p}$$

(Note: This approximation makes allowance for the smaller diameter of the pipe as compared to the coupling.)

● **Bibliography.**

1. "Oil-well Casing Failures" Robert J. Kettenburg and Fremont R. Schmieder *API Drilling and Production Practice*, 1945.
2. "Leak Resistance of Casing Joints in Tension" P. D. Thomas and A. W. Bartok *API Drilling and Production Practice*, 1941.

★ ★ ★

[b] See Appendix 2.

BALDWIN DIESELS

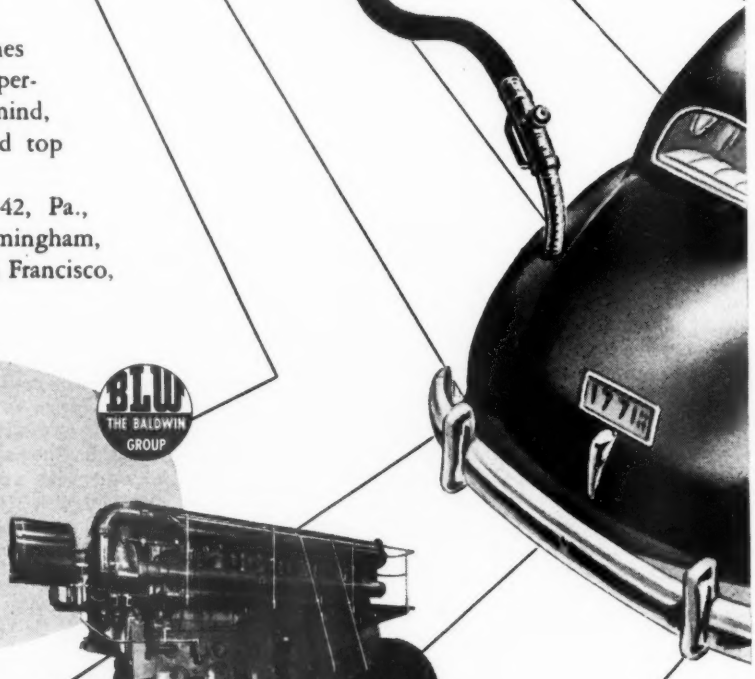
help to "make both ends meet"

Because pipe lines represent such a large investment, design is generally based on 100% capacity operation. There's no margin to make up tomorrow for oil movements missed today, so top dependability is a number one essential in the diesel pumping engines.

Baldwin diesel engines concentrate on the *precision* that assures dependability. Crank shafts, cam shafts, pins and liners are ground or honed to hair-splitting tolerances. Jigs and fixtures assure exact positioning for machining operations. The use of multiple-spindle boring machines on many operations speeds the work, and adds to accuracy.

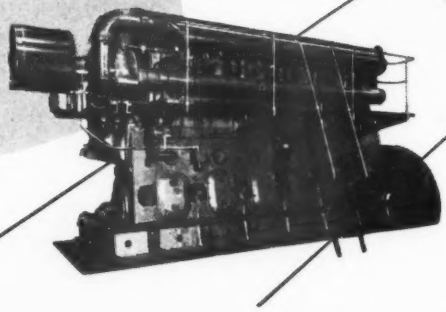
The widespread use of Baldwin Diesel Engines throughout the oil field is the best index to their performance. If you have any new installations in mind, use Baldwins for top efficiency, top economy, and top reliability.

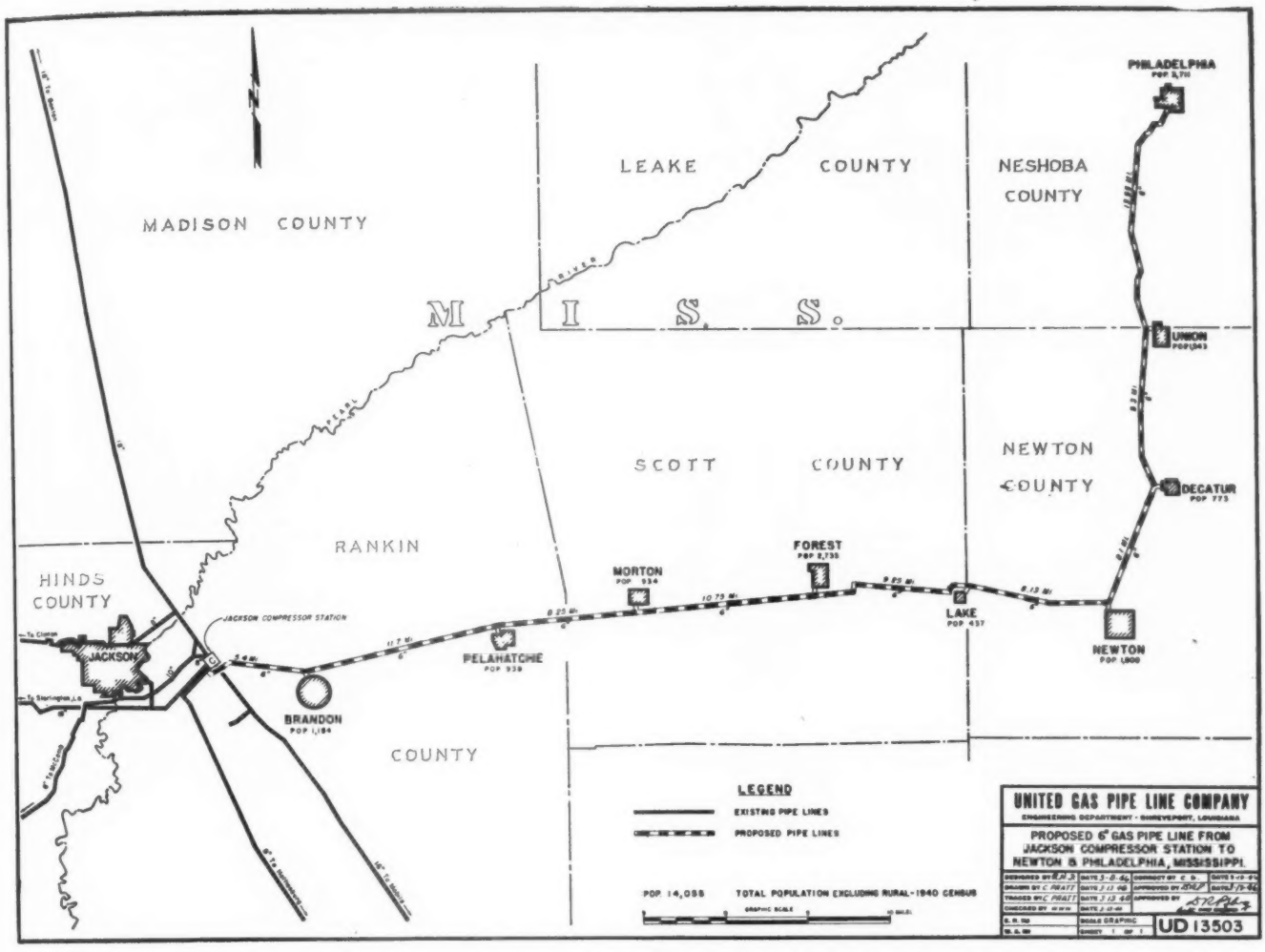
The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Philadelphia, New York, Boston, Birmingham, Houston, St. Louis, Chicago, Cleveland, Detroit, San Francisco, Washington, Pittsburgh, Seattle.



BLW THE BALDWIN GROUP

BALDWIN
DIESEL ENGINES





The broken line on the map above shows the course of the Jackson-Philadelphia line through Rankin, Scott, Newton, and Neshoba counties. Towns to be served through distribution facilities of United Gas Corporation are also shown.

United completes Mississippi pipe line

By O. C. IRVINE, United Gas Pipe Line Company

EXCLUSIVE

UNITED GAS PIPE LINE COMPANY has completed the construction of its "Philadelphia Project," an 86-mile, 6-in. natural gas transmission pipe line beginning near Jackson, Mississippi, and terminating at Philadelphia, Neshoba County, Mississippi. The new transmission artery makes natural gas produced in Mississippi available to approximately 3000 consumers in four of the state's counties, including industrial, commercial, domestic, and farm tap customers who have not previously been provided with natural gas service.

Nine city gate measuring stations included in the pipe-line project will handle the gas delivered to as many towns along its route. Each of these towns will be served through the distribution facilities of United Gas Corporation's operating division with service operations assigned to the corporation's Mississippi division.

Beginning at the site of United's Jackson compressor station, approximately 10 miles east of Jackson, the line runs in an easterly direction through Rankin, Scott, and Newton counties, thence northward through Neshoba County to its Philadelphia terminus. All gas for the new pipe line will be supplied from the Gwinville field, situated south of Jackson in Jefferson Davis County, Mississippi, where through gas purchase arrangements with other operators, 11 wells are presently connected to United's gathering system.

Transmission of the gas from Gwinville to its point of entry into the Philadelphia 6-in. line will be through approximately nine miles of 10-in. and 12-in. line from the Gwinville field to United's Jackson-Hattiesburg 8-in. line, then north through this line for approximately 42 miles to the point near the Jackson compressor station where the 8-in. line makes a junction with the new 6-in. carrier.

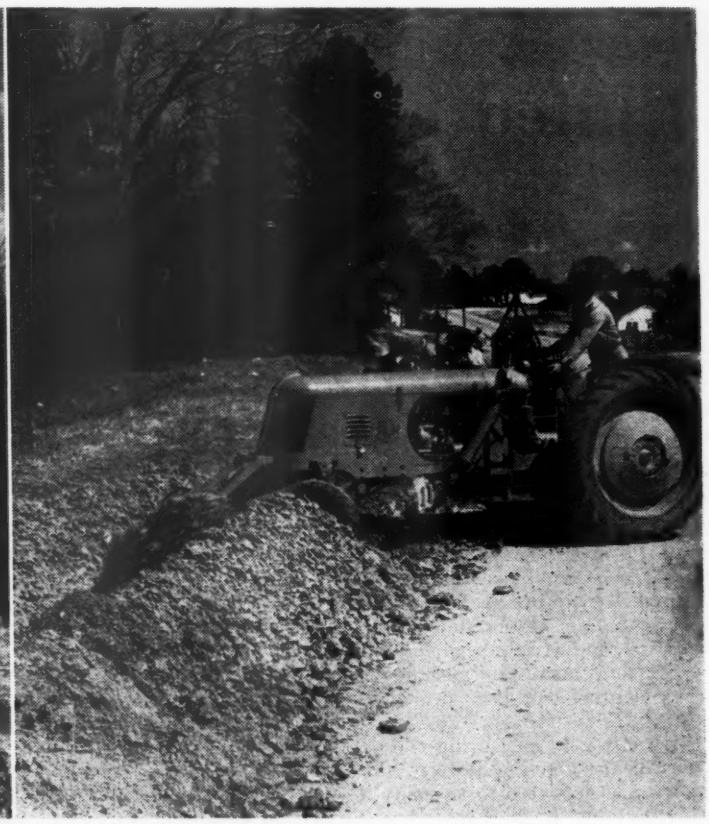
The 42-mile section of the Jackson-Hattiesburg line between the Gwinville tie-in and the Philadelphia line take-off has been disconnected from other parts of the system, thus segregating the section from all other lines and providing for a continuous flow of gas from the Gwinville field to Philadelphia. No compressor station facilities will be required on the Jackson-Philadelphia line be-

A scene showing one of the various construction stages of the main transmission line. Above, a finish welder joins two sections of the 6-in. pipe.

Natural gas service approaches Morton, Mississippi. Construction scene here is on distribution tap line as the welder follows close behind ditching machine.

Six-inch pipe line from Jackson compressor station crosses rough terrain north of Linwood gate.

Bulldozer hastens the job of backfilling the distribution tap line at Morton, Mississippi,



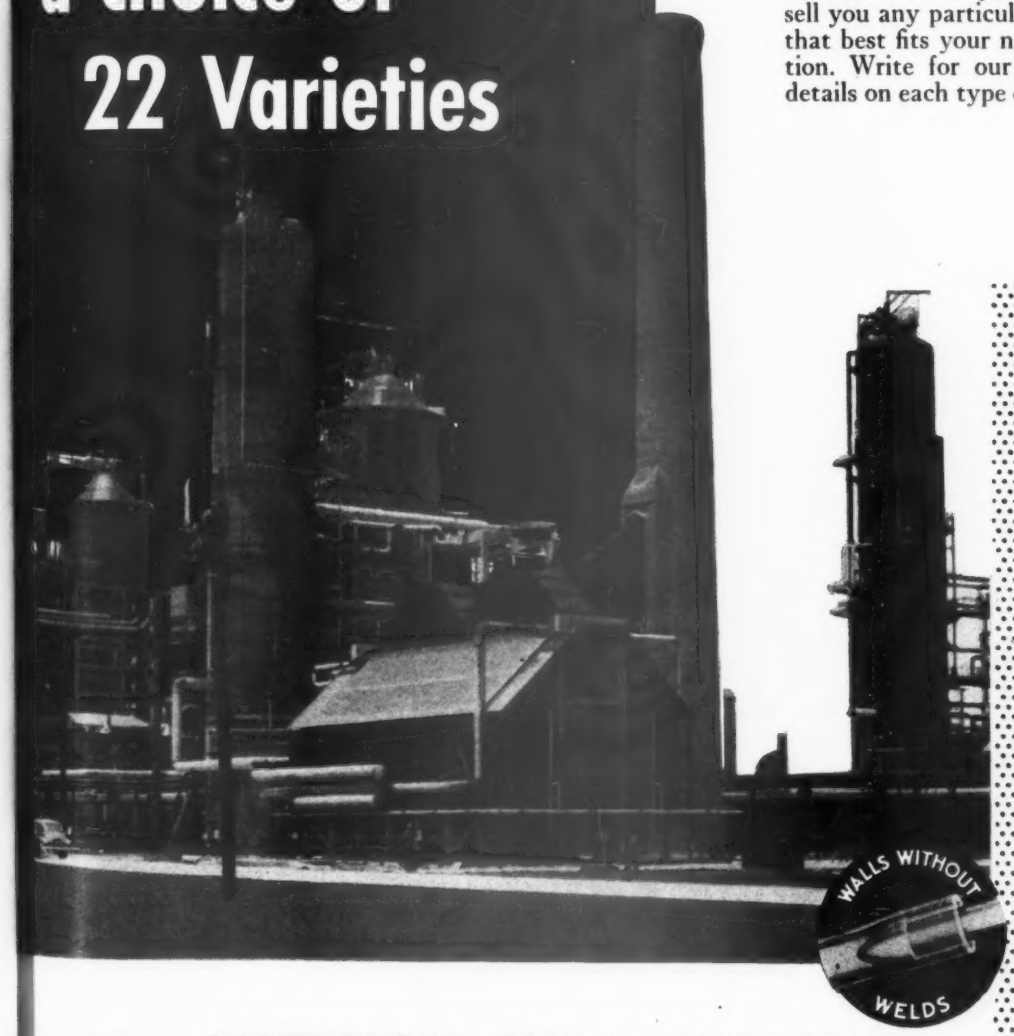
...an be choosy again

National's Complete Tube Service offers a choice of 22 Varieties

The 22 varieties of seamless steel tubes now offered by NATIONAL allow you to select the best analysis for any particular job. And if you are not sure which analysis is correct, NATIONAL's Tubing Specialists can give you the technical assistance necessary to determine the right tubing for maximum service.

In some refineries, the life of still tubes has been increased 50% to 100% merely by changing to a better grade of U·S·S NATIONAL Chrome-Moly Tubing. For high temperature corrosive work NATIONAL Stainless Steel Tubing is unsurpassed for long service life and freedom from trouble.

With production at an all-time high, the better grades of tubing justify their cost by reducing down time to a minimum. If for any reason, you are not getting adequate service from your pipe and tubing, put it up to the NATIONAL Refinery Tubing Specialist. His services cost you nothing and he is not trying to sell you any particular grade of tubing—only the one that best fits your needs for most economical operation. Write for our refinery book giving complete details on each type of refinery tubing.



- Low Carbon
- Low Carbon, ½ Moly.
- Low Carbon, ½ Cr., ½ Moly.
- Low Carbon, 1 Moly.
- 1¼ Cr., ½ Moly.
- 1¾ Cr., ¾ Moly., ¾ Sil. (Bain Alloy)
- 2 Cr., ½ Moly.
- 2 Cr., ½ Moly., 1¼ Sil.
- 2¼ Cr., 1 Moly.
- 2½ Cr., ½ Moly., ¾ Sil.
- 3 Cr., ½ Moly., 1¼ Sil.
- 3 Cr., 1 Moly.
- 5 Cr., ½ Moly.
- 5 Cr., ½ Moly., 1½ Sil.
- 5 Cr., ½ Moly., Titanium
- 5 Cr., ½ Moly., Columbium
- 7 Cr., ½ Moly.
- 8 Cr., 1 Moly.
- 17 Cr.
- 18-8
- 18-8 Titanium
- 18-8 Columbium

For still tubes—condenser tubes—heat-exchanger tubes — refinery piping

NATIONAL TUBE COMPANY
PITTSBURGH, PA.
Tubing Specialties Division
United States Steel Export Company, New York

UNITED STATES STEEL

cause all connected wells have pressures of 3000 psi or greater.

Actual work on the Jackson-Philadelphia pipe line began late in November and, although adverse weather conditions throughout the construction period hindered progress, the line was ready for service at mid-April, following installation of main line gate valves and completion of cleaning, blowing, and testing the line. All contract work on the line was completed April 27, with remaining clean-up, painting, and dress-up operations to be handled by crews of United Gas Pipe Line Company's Jackson district.

In addition to rainy, and at times extremely cold, weather construction crews were confronted with both hilly and swampy terrain. Particularly rough going was met in Newton and Neshoba counties where it was difficult to work across the low bottoms in wet weather.

All main line and tap valves on the Jackson-Philadelphia pipe line were insulated when installed. This advance precaution was taken in preparation for the later installation of cathodic protection units in the event such units may be required at some future time. Twelve main line plug valves with 2-in. blow-offs on either side were installed; and the routing of the new transmission line required 58 railroad, highway, and rural road crossings. Although numerous drainage canals and small streams were crossed by the pipe line, no multiple crossings were necessary.

Completion of the Philadelphia Project offers a typical example of United's program to carry forward its postwar expansion of facilities and service in the face of material shortages and other handicaps. Removal operations at many points throughout the United Gas system, which have done much toward conserving still critical materials, contributed greatly to the success of this project.

As a result of this replacement of certain facilities in a location of greater need, natural gas service is now provided for an area where no such service was available before. A new consumer market with promising potentialities has been opened for future development through provision of dependable, low-cost fuel, always a determining factor in a territory's expansion.

In order to obtain enough pipe for the Philadelphia project, it was necessary to use various weights, ranging from 8.0 lb to 17.0 lb per ft. Line pipe used in the construction beginning at the Jackson compressor station site was removed from the Slidell lateral line in the southeastern Louisiana section of United's Jackson pipe-line district where rearrangement of transmission facilities permitted the salvage and reuse of this quantity of pipe. Additional reclaimed and reconditioned pipe was procured through removals from the Rodessa field in the Shreveport district and from the Henderson loop line in the Dallas district.

The Slidell pipe, weighing 12.89 lb per ft, was the heaviest available, except a very small amount of 17.0-lb pipe used for railroad and highway crossings. Consequently, it was installed at the beginning of the line where the highest operating pressure will be maintained.

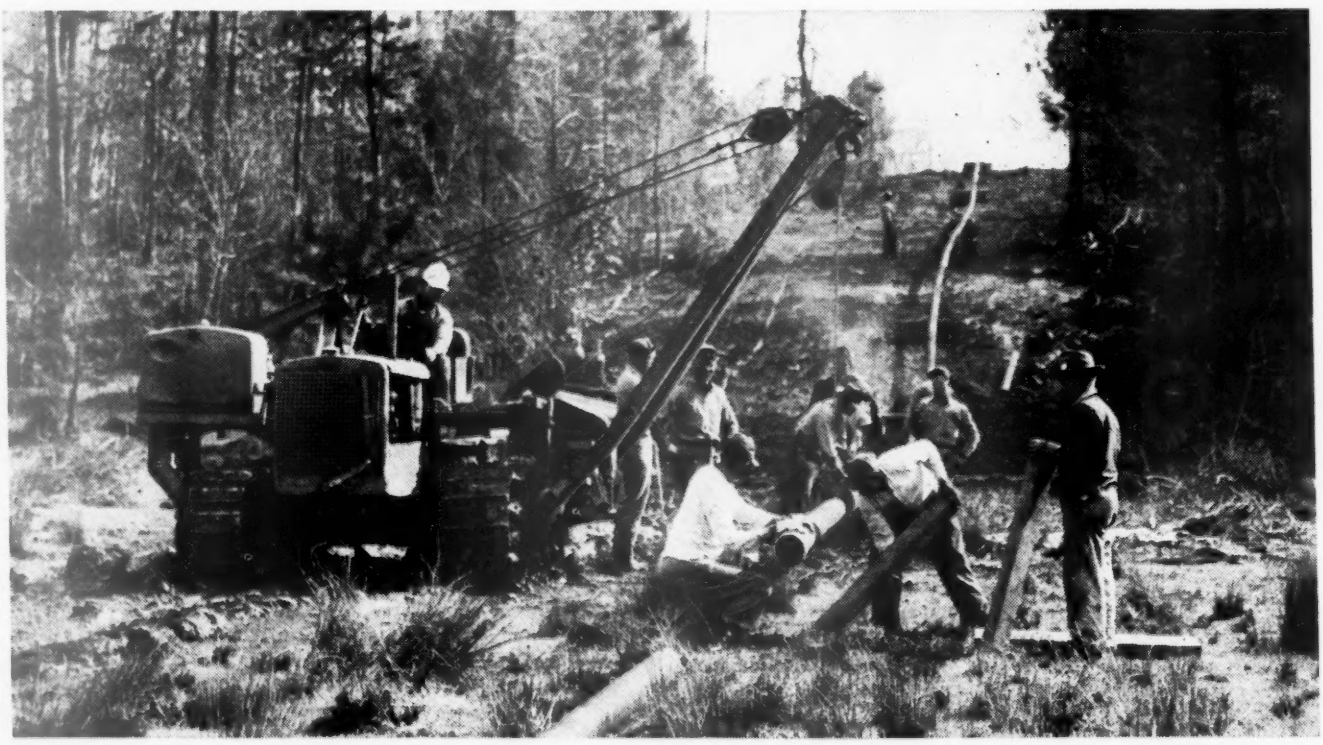
The remainder of the line is made up principally of "Invasion" pipe, so called because it was designed for extending fuel lines to invading armies in the recent war. It was used on this project because of the shortage of the standard line pipe that otherwise would have gone into the construction. The entire line was tested at 425 psi pressure before being put into service for continuous operation.

Invasion pipe was received in 20-ft. lengths with 6⅝-in. OD adapters 5½ in. long on each end for the couplings used by invasion army pipe-line operations. Before being used on the Philadelphia job, designed for solid welded construction, the pipe had to have these couplings removed.

Due to a difference in pipe sizes, the Invasion pipe being 6-in. OD and the remainder 6-in. ID, only the first three block valve sections of the line, all of the same size pipe, could be internally cleaned with a plug or "pig." Invasion pipe was slipped into the ends of the 6-in. ID pipe for welding, and sections having the resultant irregular inside dimensions were cleaned internally by blowing with gas.

Standard measuring stations with positive displacement meters were installed at each of the nine towns reached by the new pipe line, the meters and regulating equipment varying in accordance with the estimated requirements at each location. Meter and regulator installations were handled by regular crews of

The line-up crew, shown below laying 6-in. pipe on skids in preparation for welding, performed one of the many rugged tasks in connection with construction of the Jackson-Philadelphia transmission line. The 86-mile artery, now complete, delivers gas produced in Mississippi to Mississippi consumers who had no natural gas service before.



KOEHRING *means* HEAVY-DUTY

Rugged Strength to Meet Demands of Oil Field Service

On rubber or on crawlers, Koehring excavators deliver maximum output on oil field and pipe-line jobs. Because they're built heavy and tough for rugged service, you'll have less down-time, more work-time. You get more stability, bigger lifts safer because of built-in Heavy-Duty strength.

Maintenance is simplified, because accessibility has been stressed throughout. Ease of operation gives you top performance every shift. Simple convertibility from crane to shovel, pullshovel, dragline or pile driver means usefulness is never limited to only one job.

Koehring distributors are at your service in major oil field supply centers.

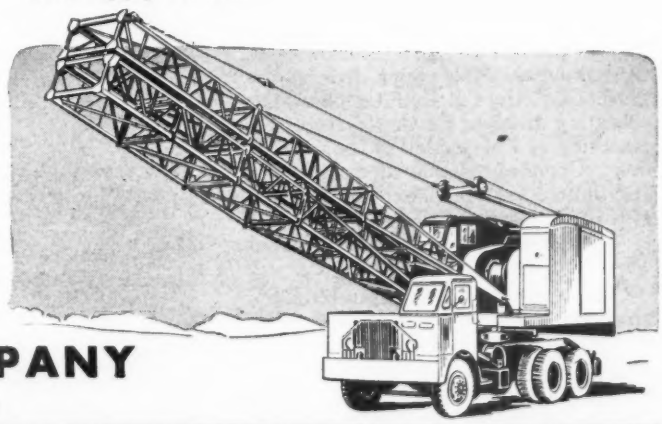
A size to suit every job:

Koehring 205 — Shovel Capacity — ½ yard
Crane Lifting Capacities:
Crawlers: 13,800 lbs.
Truck: 20,000 lbs.

Koehring 304 — Shovel Capacity — ¾ yard
Crane Lifting Capacities:
Crawlers: 23,100 lbs.
Truck: 40,000 lbs.

Koehring 605 — Shovel Capacity — 1½ yard
Crane Lifting Capacity:
Crawlers: 60,760 lbs.

Crawlers: 75% Rating
Truck: 85% Rating



KOEHRING COMPANY
Milwaukee 10, Wisconsin

HEAVY-DUTY CONSTRUCTION EQUIPMENT

(1) Blowing a section of the Philadelphia line. Note density of dust as dust and scale are blown from line on initial blow.
(2) The blow continues and dust color changes as solid particles are purged from the line.
(3) Just a faint haze remains at this stage of the blow.
(4) All clear! No dust or other foreign matter remain in the gas stream, indicated by the fluttering handkerchief.

United's Jackson district organization.

Construction of the Jackson-Philadelphia transmission pipe line was a contract job with O. C. Whitaker, Fort Worth, as the general contractor, and with United personnel acting in engineering and inspecting capacities. Inspection of pipe-line construction was under the supervision of George Waverly, veteran inspector for United, until his retirement on January 1, at which time E. W. Thompson of Jackson, assisted by D. B. Merritt and W. L. Lindsey, both also of the Jackson district, assumed inspection duties on this job.

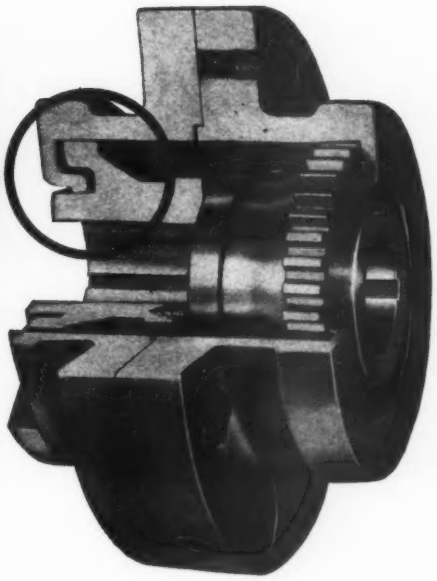
George Evanoff of Shreveport was welding inspector. Field engineering work was done by C. M. Hart, T. F. Hollenshead, Jr., and W. F. Erwin, all of United's Shreveport general office engineering department. P. O. Yeary and Robert Deason, also of the general office engineering department, handled materials and supplies.

In the order of their location from Jackson, the towns to be served by the Jackson-Philadelphia line through the distribution facilities of United Gas Corporation's Mississippi division are Brandon, Pelahatchie, Morton, Forest, Lake, Newton, Decatur, Union, and Philadelphia. Included in the estimated 2900 customers of all types to be served in the localities above are approximately 100 rural consumers to be connected by farm taps outside the towns.

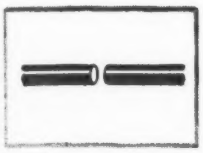
Like the construction of the Jackson-Philadelphia main transmission line, construction of distribution facilities that will depend upon it for their volumes of natural gas was also on a contract basis. Guy Bumpas, Mississippi division engineer for United Gas Corporation's operating division, was in charge of engineering and inspection of the installations. Upon completion of each of the distribution systems, service operation of the new local system was turned over to operating personnel of the United Gas Corporation.

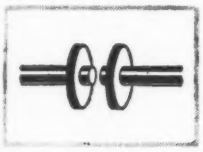
Completion of the Jackson-Philadelphia transmission pipe line and distribution systems in the communities it reaches marks the beginning of natural gas service in this section of Mississippi. Among the first of United's postwar projects to extend its service, it is one of many similar projects in an overall program of progessive expansion planned by the United companies. ★ ★ ★

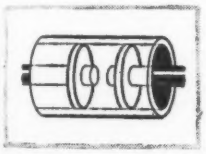
Specify FAST'S—Get This EXTRA Protection *Against* COUPLING SHUTDOWNS

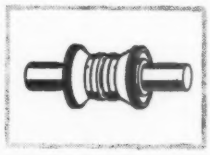


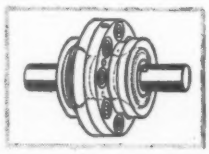
Metal-to-Metal Seal Keeps Oil Clean for Continuous Service!









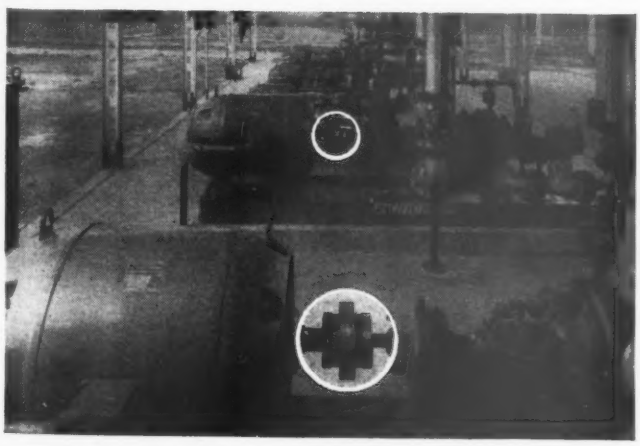


Fast's Couplings Are Simple as A-B-C

See the simple development of Fast's Couplings. A splined hub on each shaft end, a sleeve with internal splines to mesh. Oil in the sleeve carries the load between the splines.

You can trust Fast's, the *original* gear-type coupling, which eliminated the need for *perishable* parts! The load-carrying oil in a Fast's Coupling is guarded by a positive metal-to-metal seal . . . the *exclusive* "rocking bearing" shown in the circle. The oil is kept free of moisture, dust and grit. No perishable packing rings are used. That's why you get *uninterrupted* power transmission with Fast's.

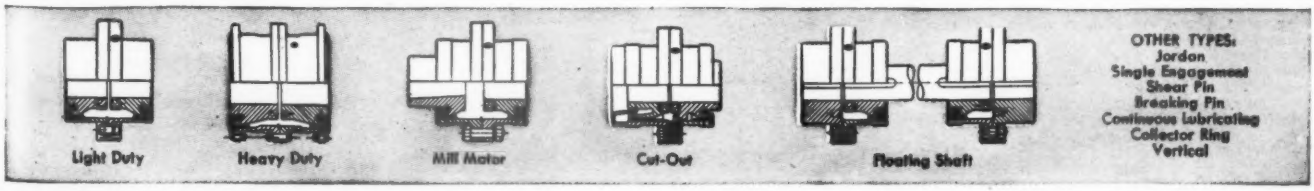
When you buy Fast's Couplings, you buy many years of top engineering experience, Koppers' high standard of workmanship and unexcelled coupling service. It will pay you to install Fast's . . . for longer machine life, lower upkeep costs, minimum shutdown losses. Write today for our complete catalog to: Koppers Company, Inc., Fast's Coupling Dept., 226 Scott St., Baltimore 3, Maryland.



FAST'S COUPLINGS OF TWO TYPES transmit power to this series of centrifugal pumps at the Warren Petroleum Company's Halliday, Texas, installation.

K KOPPERS

FAST'S *self-aligning* COUPLINGS



Economics of dual wells in Waskom field

By K. MARSHALL FAGIN, *Field Editor*

EXCLUSIVE

IMPROVEMENTS in the long-range outlook for natural gas demand, price at the wellhead, dual completion techniques, and wider well spacing rules are combining to encourage operators to develop and extend some of the older and little-known gas fields such as Waskom, which was discovered in 1924 and is situated in the southeastern part of Harrison County, Texas.

About 200 shallow gas wells were drilled in a 2000-acre area near the crest of the anticlinal structure, which centers around the Texas-Louisiana border town of Waskom. Most of these wells were drilled to the Nacatoch, Blossom, and other sands of Upper Cretaceous age at depths of 900 and 3000 ft. A number of them drilled in 1936 produced some 35-API gravity oil, but the production from most of the wells was largely gas. Some of these wells are still in operation, but pressures and volumes are low

TABLE 1. Gas and condensate production data on the Waskom field, Harrison County, Texas, and Caddo Parish, Louisiana.

	Gas production, MM cu ft			Oil and condensate production, bbl		
Year	Texas	Louisiana	Total	Texas	Louisiana	Total
1924 to 1932 (records not available)						
1932	2,131					
1933	1,736					
1934	1,756					
1935	1,817					
1936	1,878					
1937	1,665			23,317		
1938	2,132			19,879		
1939	3,286			21,820		
1940	5,017			25,304		
1941	7,276	410	7,686	63,312	3,213	66,525
1942	8,237	1,015	9,252	81,951	4,136	86,087
1943	10,025	537	10,562	163,925	8,361	172,286
1944	9,000	354	9,354	147,584	6,241	153,825
1945	8,100	350	8,450	110,718	6,085	116,803
1946	8,000	300	8,300	81,427	7,233	88,660
Estimated cumulative: 1-1-47	153,000	15,000	168,000	860,000	40,000	900,000

Note: Cumulative oil production from the shallow wells (900 to 3000 ft) is estimated to be 140,000 bbl from the Texas portion and 20,000 bbl from the Louisiana portion of the field. The rest of the cumulative production is counted as condensate and is almost entirely from the Travis Peak wells.

TABLE 2. Approximate cost of drilling and completing a dual gas well in Waskom.

Drilling 6200 ft	$31,000
Day work for 13 days	7,150
Casing, tubing, packer, and wellhead connections	14,245
Drilling mud and chemicals	2,655
Acid and acidizing	1,910
Cement, cementing, and squeezing	2,720
Gun-perforating service	3,475
Electric logging service	530
Tanks, separators, and heater	8,015
Total	$71,100

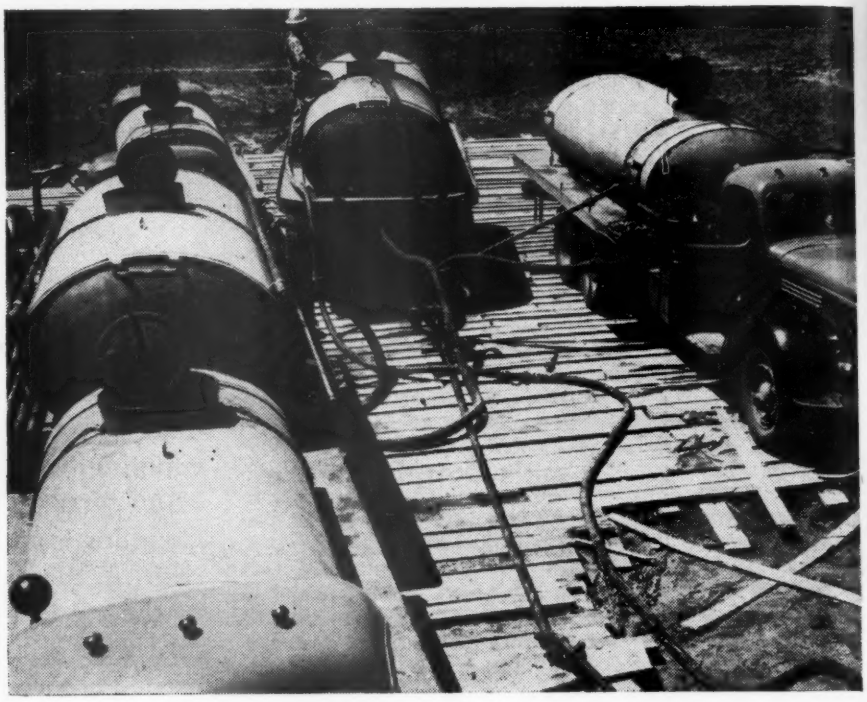
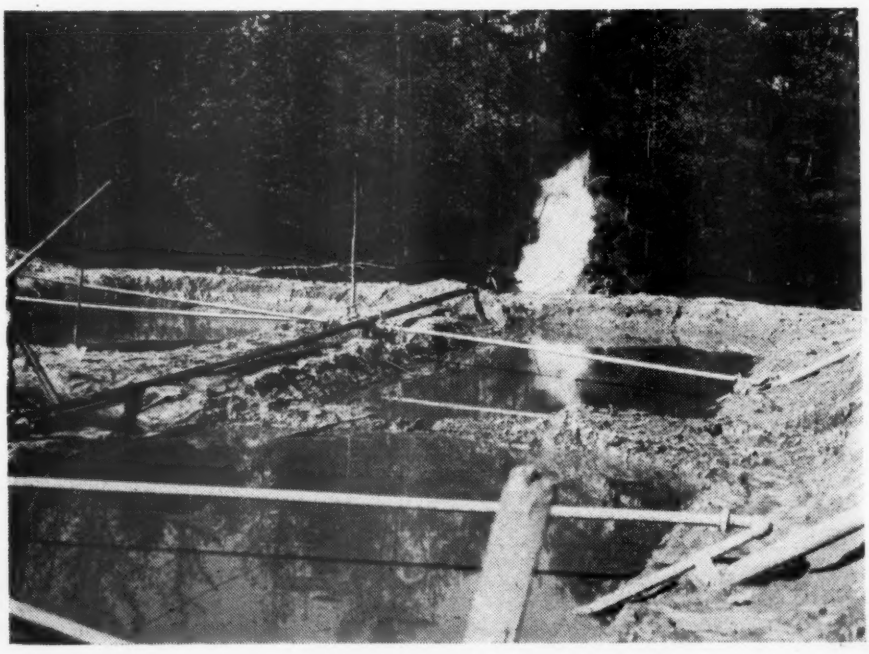


FIG. 1. About 10,000 gal of acid is picked up through flexible suction hoses by the power pump on the truck at the right and pumped into the Upper Pettit zone through the pipe (foreground) equipped with high-pressure flexible connections.

FIG. 2. After flowing slugs of mud and acid water for an hour or so from Travis Peak and Upper Pettit through clean-out lines, the gas begins to burn. It is important to flow the well long enough and hard enough to clean out all mud or water that might kill either zone for a "dead" dual completion might be hard to revive.



WILL MEET YOUR REQUIREMENTS

Photos—courtesy of the EAST TEXAS SALT WATER DISPOSAL COMPANY.

Salt Water Disposal
Water Flooding or
Pressure Maintenance

because:

1 "OILWELL" PUMPS are designed to give dependable performance over long periods of continuous operation. Routine maintenance check-ups are made with ease and when adjustments are needed they can be completed quickly.

2 "OILWELL" PUMPS are of the reciprocating type and their capacity output does not fall off under gradually increasing pressures.

3 "OILWELL" PUMPS permit capacity changes to meet changing operating conditions. Besides the capacity selection provided through piston and liner sizes, engine speeds can be regulated to conform with current operating requirements.

★ THE FOLLOWING "OILWELL" PUMPS...

are furnished with special assemblies to meet specific conditions, such as corrosion, encountered in the various types of pressure-maintenance applications.

★	Types of Liners Available	Liner Sizes Available Inches	Recommended Operating Speed Range R.P.M.	Theoretical Displacement Range with Available Liners at Recommended speeds G.P.M.	Working Pressure Range with Available Liners—P.S.I.
No. 6P-HD*	Bronze	4, 3½, 3	20—100	14—126	410—755
No. 8P-HD	Di-Hard Bronze	5 only 5, 4½, 4	20—80	24—206	600—1280
No. 12-P	Di-Hard Bronze	5 only 5, 4½, 4	20—70	50—270	540—875
No. 612-P	Di-Hard Bronze	6, 5½, 5 6, 5½, 5	20—70	75—390	520—765
No. 712-P	Di-Hard Bronze	7¼, 6¾, 6, 5 7¼, 6¾, 6, 5	20—70	75—580	550—1200
No. 14P-HD	Di-Hard Bronze	7¼, 6¾ 6, 5½ 7¼, 6¾ 6, 5½	20—65	105—620	765—1375
No. 36-P	(Plunger Type) Di-Hard Aluminum-Bronze Stainless Steel Steel	(Plunger Size) 3 3, 2¾, 2½, 2¼ 3, 2¾, 2½, 2¼ 3, 2¾, 2½, 2¼	20—140	6.5—77	1420—2510

*All bronze fluid end available.

OIL WELL SUPPLY COMPANY

Branches Serving All Oil Fields

Executive Office—Dallas, Texas
Export Division Office—
30 Rockefeller Plaza
New York 20, N. Y.

Division Offices—Columbus, Ohio
Dallas, Texas . . . Denver, Colorado
Houston, Texas. .Tulsa, Oklahoma
Los Angeles, California

UNITED STATES STEEL

"OILWELL"

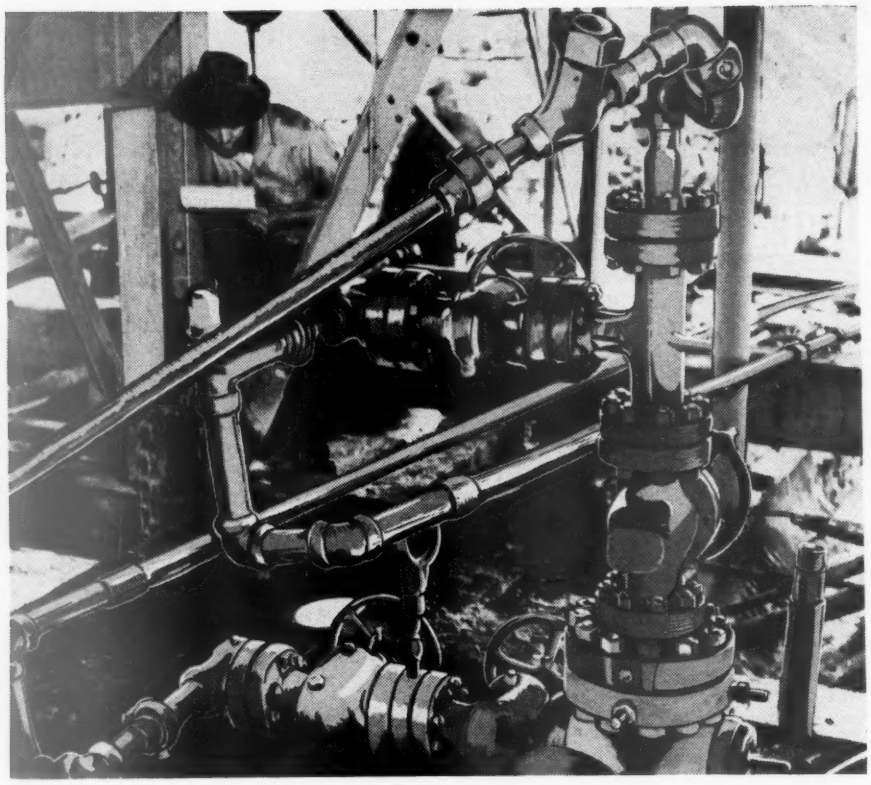


FIG. 3. Casing pressure behavior is being recorded as 10,000 gal of acid is being pumped into the Upper Pettit formation through the tubing connection (upper right). The clean-out lines from the Christmas tree to the flare (Fig. 2) are connected but the valves are closed. Injection of acid takes about 1 hr.

and unimportant compared with the deliverability of the deeper wells in formations of Lower Cretaceous age that have been drilled since 1938.

● **Development of the deeper producing zones.** Arkansas Fuel Oil Company's Abney A-1 well, which is about one mile southwest of the Waskom townsite, was drilled to the first deep pay zone, the Hill "sand," in 1938. The well blew out, but was finally completed as the discovery gas well for the Hill oolitic lime formation. (See Table 3 for other data on the producing formations.)

The continued search for oil production in deeper formations led to the discovery of gas production in the Travis Peak zone in 1939. Three wells were completed in this zone in that year. Nine Travis Peak wells were completed in 1940, and four more in 1941. Development of the field was delayed during the war years by the PAW 640-acre drilling unit requirements, the lack of demand for additional gas from this area, and apparent failure to find commercial crude oil production in any of the Travis Peak sand stringers.

Discovery of substantial gas production in the Upper Pettit lime in 1945 caused the operators of many of the Travis Peak wells to recomplete them as dual wells during 1946. Table 4 and the map of the field show that 25 wells are now completed in the Upper Pettit formation. One is a single completion, and 24 are dually completed in the Travis Peak, Lower Pettit, or Hill zones.

● **Size of the dually completed gas wells.** Most of the dual wells at this time are completed in the Upper Pettit and Travis Peak formations. Dual completion in the Upper Pettit is due partly to offset requirements and partly to the fact that the open flow potentials in this zone are higher than those obtained so far in the Hill and Lower Pettit formations.

The open flow potential of the three Hill wells is about 34,000,000 cu ft, or 11,000,000 cu ft per well. The open flow potentials of the 25 Upper Pettit wells range from 2,000,000 to 250,000,000 cu ft per well with an average of 47,000,000 cu ft per well. One of the Lower Pettit wells has a potential of 12,000,000 cu ft, and the other one has a potential of about 1,000,000 cu ft. The 38 Travis Peak wells have open flow potentials ranging from 4,000,000 to 90,000,000 cu ft with the average potential being about 23,000,000 cu ft per well.

The average well has a potential of 30,000,000 cu ft in each zone in which it is completed. The average dually completed well, therefore, has a potential of about 60,000,000 cu ft. Although this is not as large as the average dually completed wells in some other gas fields, it is evident that the dual completion technique is aiding the operators in the economic development of the deeper gas producing zones.

Table 1 shows that the oil and condensate produced from all zones has not averaged more than 16 bbl per MM cu ft, and that only 10 bbl per MM cu ft was produced during 1946. This relatively low liquid content may be due to the way the wells have been produced, or to the fact that much of the gas is processed for liquid hydrocarbons after it leaves the lease. It is understood that the liquid products of the gasoline plant in the field are not included in the production records. In any case, the gas-condensate ratio in most of the wells seems to be high. The range as calculated from Table 1 is from 60 to 100 M cu ft per bbl.

TABLE 3. Data on producing formations in Waskom.

Name	Age	Character	Depth, ft	Thickness, ft*
Nacatoch	Upper cretaceous	Sand	920	50
Blossom†	Upper cretaceous	Sand	1900	20
Hill‡	Lower cretaceous	Oolitic lime	4800	30
Upper Pettit	Lower cretaceous	Lime	5570	30
Lower Pettit	Lower cretaceous	Lime	5760	10
Travis Peak§	Lower cretaceous	Sand stringers	5820	100

*The average thickness of the effective porosity of these producing formations is not available, and the total thickness (shown above) may vary greatly in different parts of the field.
†Also known as the Tokio sand.
‡Also known as the Rodessa lime or Hill "sand."
§Also known as the Hosston formation.

Note: Some production has been obtained from the Barlow, Florsheim, and Waterman sands at 2300, 2550, and 2800 ft, respectively.

TABLE 4. Gas production and wells by zones in 1939 and 1942 in the Texas portion of the Waskom field.

Shallow sands	Depth, ft	1939		1942	
		Gas, M cu ft	No. wells	Gas, M cu ft	No. wells
Nacatoch	920	525,909	27	186,613	18
Blossom	1900	393,875	20	257,304	14
Barlow	2300	644,057	28	376,015	24
Florsheim	2550	5,598	1	1,720	1
Waterman	2900	109,285	1	50,850	1
Total		1,678,724	77	872,502	58
Deep zones:					
Hill	4800	1,606,978	1	362,265	1
Travis Peak	5820		3	6,982,090	15
Total		3,285,702	81	8,236,857	74

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 27th YEAR

You can **See** it in the Design!
Feel it in the Handling!
Check it on the Scales!

BAASH-ROSS "DU" ROTARY SLIPS ARE UNUSUALLY LIGHT WEIGHT

. and Light Weight is only ONE of *many* "DU" advantages!

Stop and think how many dozens of times the rotary slips are ed by the drilling crew during a *single* round trip. Multiply this repeated day-after-day, month-after-month operations and you readily appreciate why light weight is such an important factor look for in rotary slips. *And you really get light weight in ash-Ross "DU" Rotary Slips!*

For example, check these figures on typical sizes of "DU" ips . . .

Size of "DU" Rotary Slips	"DU" Regular (12" long)	"DU" Long (16" long)
" O.D. Slips with 4½" Liners	137 lbs.	158 lbs.
" O.D. Slips with 5⅜" Liners	146 lbs.	177 lbs.
O.D. Slips with 7" Liners	154 lbs.	196 lbs.

On these and other sizes you'll find Baash-Ross "DU" Rotary Slips are pounds lighter because all excess metal has been removed without in any way sacrificing strength or ruggedness. *Notice the deeply-cored backs that replace dead metal with a cellular rib construction that combines more-than-ample strength with minimum weight.*

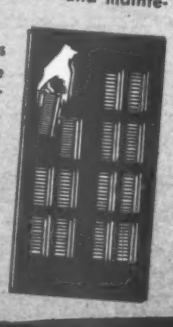
▶ **But most important** is the fact that unusually light weight is only *one* of many important advancements you get in Baash-Ross "DU" Rotary Slips. Carefully check through the features outlined below . . . compare them right down the line with *any other* make of slips . . . and you'll see why "DU" Rotary Slips are today's outstanding buy for maximum convenience, safety and all-around economy!

Baash-Ross "DU" Rotary Slips are available in both "Regular" length (12" long—for wells through 8000 ft. in depth) . . . and "Long" length (16" long—for the deepest wells and heaviest drill strings). For full details, see your nearest Baash-Ross representative—or write direct!

WHAT OTHER SLIPS COMBINE SO MANY OUTSTANDING ADVANTAGES?

3 BODY SIZES FIT 14 PIPE SIZES: With "DU" Slips you don't need a separate p for each size of drill pipe. By simply changing the liners—a quick inex-nsive operation—*three* basic "DU" body sizes fit *all* sizes of tubing, drill pipe d casing from 2⅜" O.D. through 7" O.D. Cuts slip investment and mainte-nce to a minimum!

MONEY-SAVING SEGMENTED LINERS: "DU" Slip Liners in 4" segments instead of single long units. If you use h 12" and 16" Slips there's no need to stock liners for sizes. Simply keep a supply of 4" segments on hand—three 4" segments for 12" Slips . . . four 4" segments for Slips . . . thus greatly reducing inventory costs. If for any reason slip wear is concentrated at one , liner segments can be switched or inverted to dis-te wear without replacing any parts. Or if too worn, ce only the worn segments and use the others for addi-l service. Cuts maintenance costs to the bone!



▶ **SELF-ALIGNING HINGE:** "DU" Body Segments are not merely hinged together, but are unitized by a unique "floating" hinge that prevents *vertical* misalignment, yet permits them to adjust *laterally* to any irregularities in bore of master bushing. This assures a full, uniform grip under all conditions!

▶ **SAFETY LINER RETENTION:** "DU" Slips are so designed that *all* stresses—both of supporting the pipe and of breaking out joints—are transmitted directly from the liners to the slip body. *There are no retaining bolts or pins to become sheared and allow liners to fall into hole.* Yet liner segments can be quickly removed by simply pulling a cotter and sliding out one keystone retaining key. This double keystone key firmly mates liners and body into single rigid unit!

▶ **AND OTHER ADVANTAGES:** There are still other vital "DU" advantages . . . the safety loops on the handles that safeguard crew's hands against injury . . . the polished backs that eliminate sticking in the bore . . . the perfected grip design that will not damage the pipe . . . the flattened toes that enable "DU" Slips to stand solidly on table or floor . . . and many other unique features.

BEFORE YOU BUY ANY ROTARY SLIPS GET THE COMPLETE STORY ON "DU" ALL-AROUND SUPERIORITY!

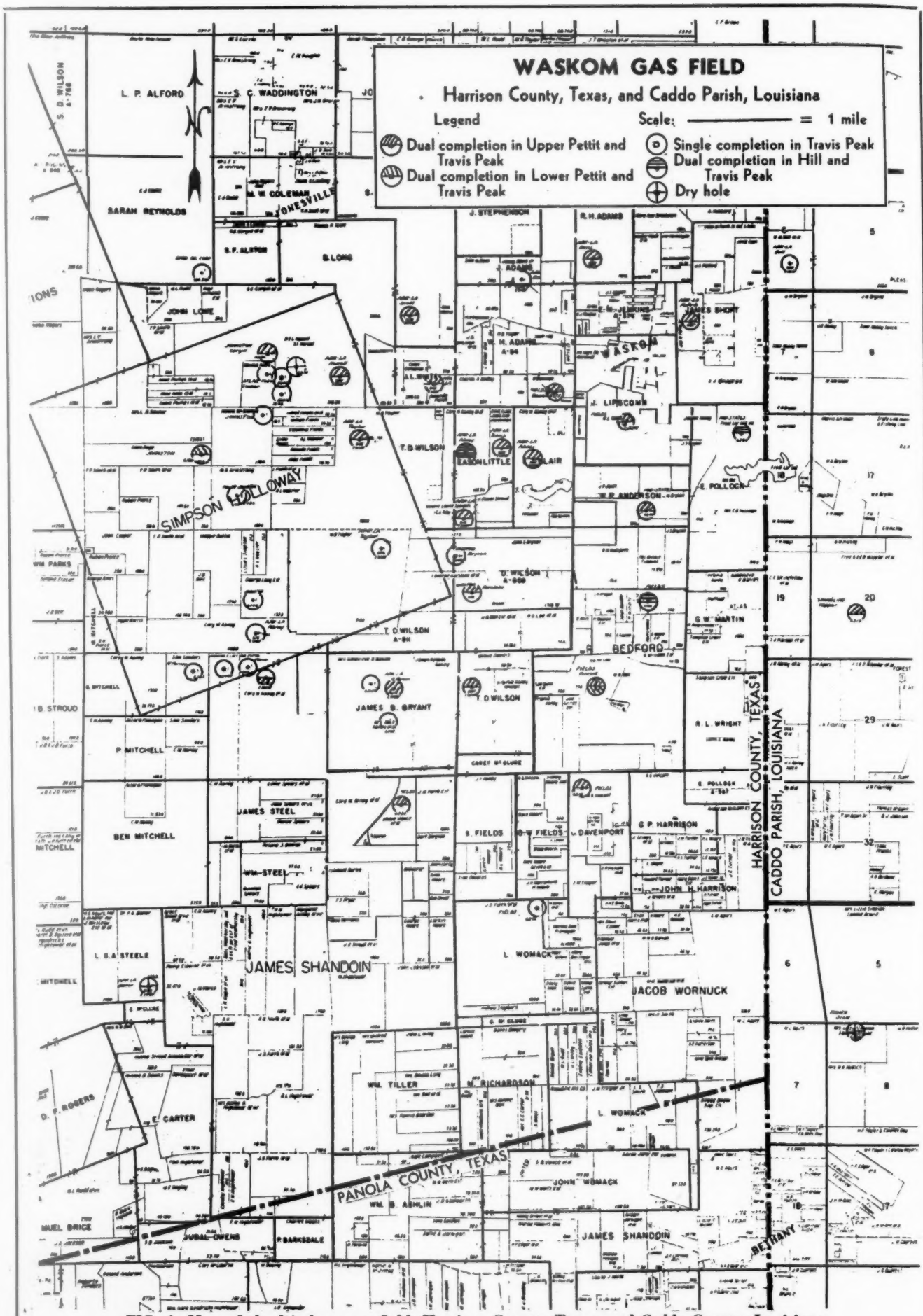


FIG. 4. Map of the Waskom gas field, Harrison County, Texas, and Caddo County, Louisiana.

how much more

of your RESERVOIR

could be REVENUE?

Or, to be more pertinent — How much of your reservoir oil do you estimate to be available as stock tank oil? How much of that estimate will actually reach a tank? Will that yield be of *maximum* value?

These questions have been answered over 600 times during the past several years in Core Lab's extensive Reservoir Fluid Analysis Laboratory.

From a comprehensive analysis of reservoir fluid, several types of data are obtained from which different estimates may be made. All serve the same general purpose — *to indicate the best operating procedure for a particular reservoir.*

First, from your point of view, are the data from "Flash" tests. These tests duplicate, on a laboratory scale, the operation of the field separator at various separator conditions. The best pressures are those which give the most tank oil per barrel of reservoir oil. *Accompanying this increased yield is a lowered gas-oil ratio and increased API gravity of the crude. Thus, selection of proper separator pressures may increase considerably the income from a well or reservoir.*

A second use for the formation volume factors so obtained, combined with other reservoir data, is estimation of the total fluid present in the reservoir in terms of stock tank oil. Comparison of field gas-oil ratios with the laboratory data indicates whether or not free gas is being produced along with the solution gas. If this is the case, the reservoir energy is being drained off excessively. A completion to exclude production from a gas cap may result in greater ultimate recovery.

The other three sets of data, Pressure-Volume, Differential Liberation, and Viscosity are used in predicting reservoir behavior under primary and secondary recovery. The Pressure-Volume relationship is the volume in barrels occupied by one original barrel of oil and its dissolved gas that has come out of solution as the pressure on the reservoir is reduced. From the differential liberation comes information on the amount of gas liberated at each stage in the pressure decline and the volume of the residual liquid. The pressure viscosity curve is a measure of how easily the oil will flow at each reservoir pressure.

The data listed above may be combined with formation characteristics to estimate with reasonable accuracy *ultimate recovery, recovery and gas-oil ratio at each stage in the depletion of the reservoir, and the efficiency of various pressure maintenance and secondary recovery programs.*

Reservoir fluid analysis then serves the following purposes: to indicate the best field operating procedures, to estimate quantity of oil present in the reservoir and the amount that you may reasonably expect to recover, and *to aid in selecting the best method of producing the reservoir.*

Thus, Core Lab's Reservoir Fluid Analysis serves not only as a proven technical procedure vital to efficiently Controlled Reservoir Performance, but as a sound financial investment engineered toward one purpose — more Reservoir Revenue.

CORE LABORATORIES, INC. ● DALLAS 11, TEXAS

"If it's worth coring, it's worth analyzing."

CORE

PETROLEUM RESERVOIR

TABLE 5. Well and reservoir pressure data, Waskom gas field, May 1, 1947.

Producing zone	No. wells*	Average reservoir pressure, psig	Subsea† Datum, ft
Hill	3	2101	—4600
Upper Pettit	25	2575	—5300
Lower Pettit	2	2686	—5450
Travis Peak‡	38	2707	—5700
Total	68*		

*All wells are dual completions except one in the Hill, one in the Upper Pettit, and 10 in the Travis Peak. Thus, 56 of the wells shown above are actually just 28 dual completions, so that 68 wells are completed through 40 well bores.

†The average elevation of the wells is 250 ft above sea level.

‡Eight of the Travis Peak wells produce crude oil.

● **Cost of drilling dual completions.** Table 2 shows the approximate cost of drilling and completing dual gas wells in Waskom at the present time. Some operators may be able to drill and complete dual wells for less than the $71,000 shown on the table, but this is approximately the actual cost of a recent completion. Although no attempt is made to show what part of the cost is due to making the dual completion, it is estimated that this does not add more than $10,000 to $15,000 to the cost of a single completion to the Travis Peak zone.

About five days are spent in moving in, rigging up, drilling to 1550 ft, running an electric log, running 9⅝-in. surface pipe, and cementing with 600 sacks. The bit record of a well (Fig. 6) shows the number of bits used and the time that elapses in drilling to total depth.

Some operators have found it unnecessary to use anything but natural mud in drilling to the top of the Massive anhydrite, which is encountered near 4400 ft. The natural mud has the following characteristics: Weight—about 9.2 lb per gal; Marsh funnel viscosity—about 34 sec (1 qt in and 1500 cc out); water loss—about 25 to 30 cc; and mud cake—about 4/32 in.

● **Drilling mud controlled below top of Massive Anhydrite.** Caustic soda, tannic acid, a little powdered barites, and starch are mixed in the mud near 4400 ft to obtain a drilling mud with the following characteristics: Weight—9.6 to 9.8 lb per gal; viscosity—about 38 sec; water loss—less than 20 cc; mud cake—about 1 to 2/32-in.; and a pH of 11½ to 12. Caustic soda is added from time to time to maintain the high pH value. The viscosity is maintained by adding tannic acid compounds, the water loss is kept down by adding starch, and the weight may be kept up by adding barites, but experience has shown that this kind of drilling mud picks up enough weight to eliminate the need for adding any weighting material.

More starch is added to the mud before the Travis Peak is drilled, so that the water loss will be less than 10 cc. Experience has shown that higher initial potentials are obtained in the Travis Peak wells when the water loss is kept as low as possible.

● **Drilling practices seem to affect Travis Peak potentials.** An 8¾-in. hole is drilled for running 5½-in. casing, or 9⅞-in. hole is made for 7-in. casing. Most of the recent wells are equipped with the smaller sized pipe. Electric logs are made, and the casing is run and cemented as soon as possible after the well has been drilled to its total depth of about 6100 ft in the Travis Peak. The low potentials of some Travis Peak wells have been blamed on delays in casing off the formation after it has been exposed to the drilling mud. High potentials on other wells have been credited to running casing promptly and keeping the water loss of the drilling mud at a low value of 5 or 6 cc while drilling the Travis Peak zone.

The production string is cemented with 500 sacks of cement, or enough to fill the hole behind the pipe to a point above the top of the Hill zone. After this string is tested, some operators perforate the pipe and squeeze additional cement behind the pipe between the producing zones to reduce the possibility of communication from one zone to an-

FIG. 5-A. Electric log showing section of a well from base of Massive Anhydrite (4683 ft) through the Hill zone (4802-4832 ft).

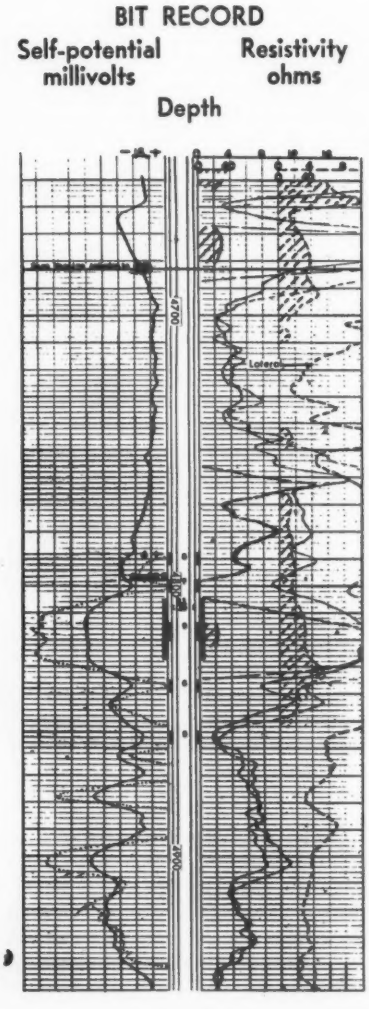
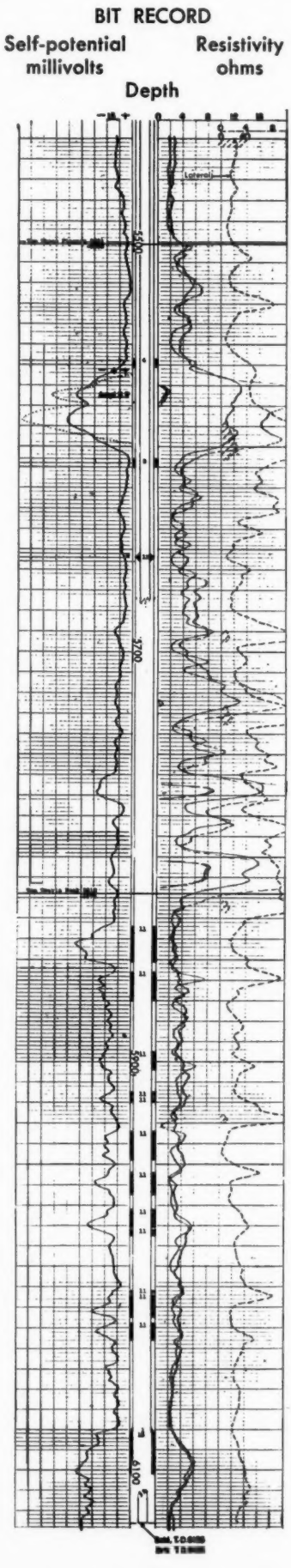


FIG. 5-B. Electric log of Pettit and Travis Peak section of well in Waskom.



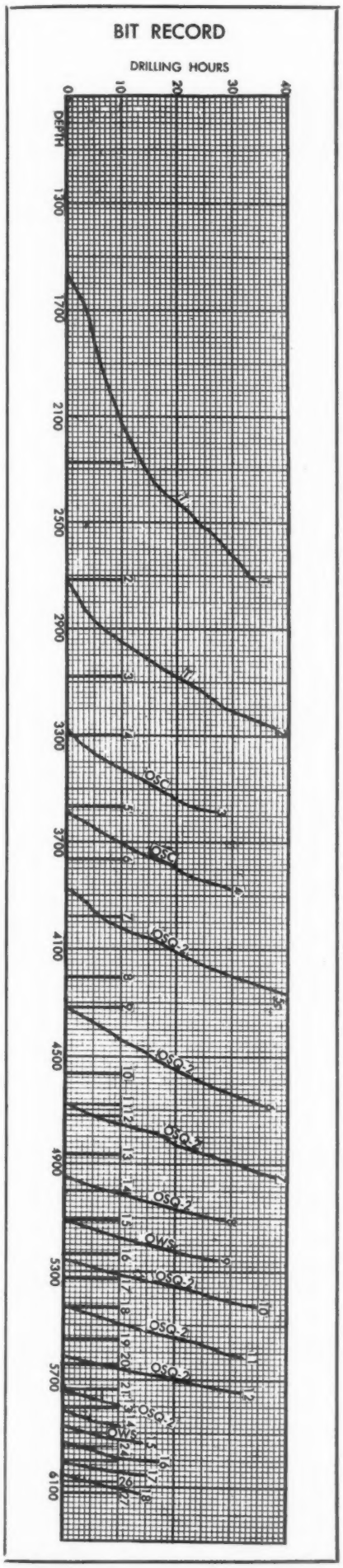


FIG. 6. Bit record of a well in the Waskom field shows that 18 bits were used during the 27 drilling days after the surface pipe was set at 1550 ft.

other. This program adds considerably to the rig day work and the cost of the well. These squeeze-cementing steps are indicated on Fig. 5, the electric log of a well.

● **Method of making the dual completions.** After the squeeze jobs have been made and tested, the casing is perforated opposite the upper gas pay, and a drill stem is made. If this proves favorable, the casing is perforated opposite the pay sections in the Travis Peak zone (or lower pay). The casing is then scraped out with reamer on the drill stem, and the tubing is run with a packer and side-door choke that will permit the testing of the upper zone through the tubing. The packer is set between the producing zones with the choke open. The mud above the packer is displaced with water by pumping it down the tubing and through the circulating port, the lower pay being shut off below the choke and packer.

About 10,000 gal of acid is pumped into the Upper Pettit formation as soon as the mud has been displaced. The upper pay is then cleaned out through the tubing and casing. The tubing is then separated from the casing, and the lower pay is opened up, so that it unloads the drilling fluid below the packer, and cleans itself out through the tubing. Both pays are allowed to clean themselves out. The lower pay produces through the tubing, and the upper pay through the casing connections. The Travis Peak formation is not acidized, and, of course, if it fails to clean itself out naturally, it may be swabbed in.

The new field rules of the Railroad Commission of Texas allocates gas production from the field to the individual wells on the basis of acreage and reservoir pressure. The standard proration unit is 640 acres per well with 10 per cent more acreage allowed in a unit under certain circumstances. ★ ★ ★

The dry ice man cometh

REMEMBER the man who killed a wild well with two bushels of golf balls? The fellow who plugged a hole at 6500 ft in a string of tubing with a lead ball and a piece of shirt off a roughneck's back? In case you've forgotten, his name is I. A. Miller, general superintendent for Otis Pressure Control, Inc., and he has recently added another "method" to his private operating manual.

Recently, a drilling crew near Baton Rouge was pulling pipe from an 8600-ft hole. Several stands had been racked when the well began to kick. Using the only equipment available, the crew stabbed a very low pressure valve on the top joint, which was 45 ft above the derrick floor. Then, after surveying this setup with due caution, they decided to find out just how much pressure they had by the tail. Plugging a gauge in on their improvised control head, they soon learned the awful truth. Twelve-hundred psi against a low pressure valve!

At that point, the drilling superintendent decided that "enough was enough" and called Otis Pressure Control, at New Iberia, Louisiana. The call was then relayed to Otis' general offices in Dallas and several methods of overcoming the emergency were discussed.

Enter, Miller. Yes, he had an idea that he had already done some experimenting on, just in case this sort of thing ever came up.

A short time later he, accompanied by L. M. Wilhoit, assistant to general superintendent, and C. A. Kizer, pilot of Otis' airplane, were winging their way toward Baton Rouge. The only equipment carried was a large cardboard box. In the meantime a 24-in. by 12-in. piece of sheet steel had been rushed to the rig from New Iberia.

Arriving on location at 10 p.m., Miller took one look at the pressure gauge, opened the valve to make certain that mud was to the top of the drill pipe, and directed the crew to fashion a hollow container out of the sheet steel by wrapping it around the drill pipe at the rotary table. This done, he opened his mysterious cardboard box and dumped 100 lb of dry ice into the metal container encircling the pipe. It was 10:25 p.m.

In the meantime Wilhoit had taken a sample of the fluid and prepared it for a similar treatment. Within 10 minutes the sample had frozen solid, indicating that pressure in the pipe was plugged, and 20 minutes later the low pressure valve was removed and high pressure connections installed.

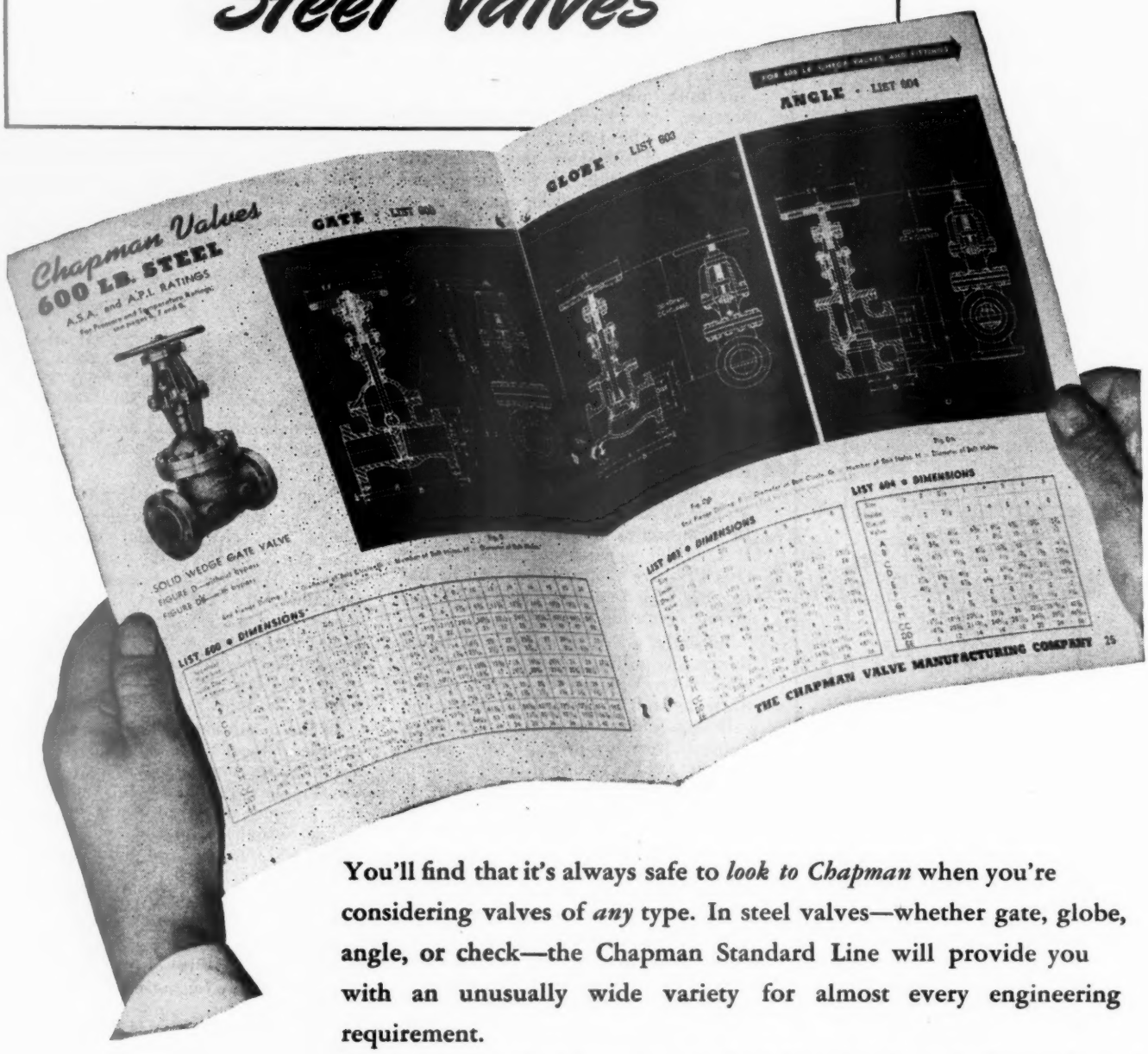
With the dry ice removed the job was completed. Total time—one hour.

At last report, the drilling superintendent was still cracking his head against the kelly for not having thought of it first.

Note: Although, Mr. Miller, as general superintendent of Otis Pressure Control, Inc., has supervised hundreds of successful wire line and pressure tubing jobs under extreme conditions he emphatically *does not recommend the operation described above as a standard procedure, even under similar circumstances.* This particular service was performed with professional forethought, use of data compiled from previous experiments, and serious consideration of all circumstances involved. ★ ★ ★

LOOK TO CHAPMAN

For the BEST in Steel Valves

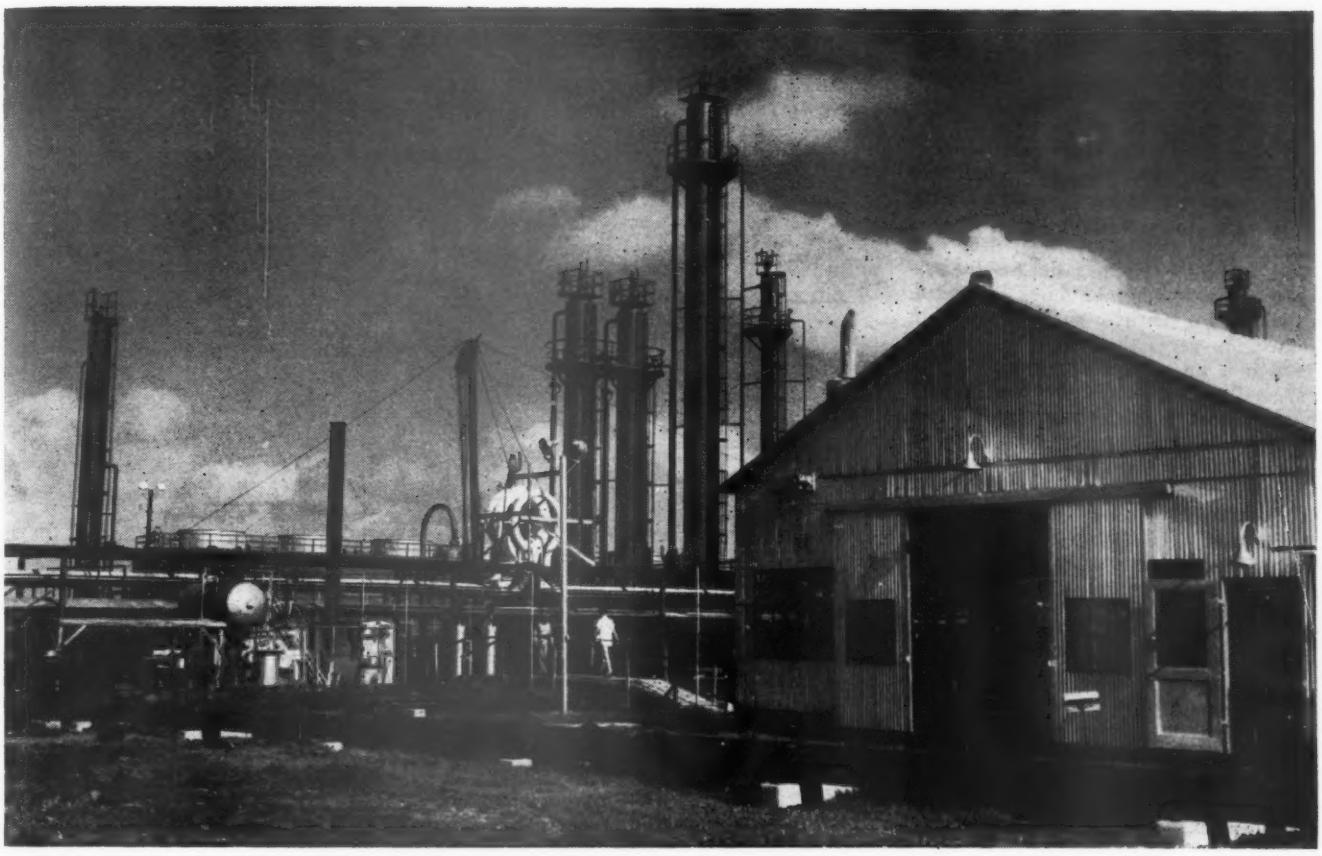


You'll find that it's always safe to *look to Chapman* when you're considering valves of *any* type. In steel valves—whether gate, globe, angle, or check—the Chapman Standard Line will provide you with an unusually wide variety for almost every engineering requirement.

That's because the Chapman Standard Line has been built up through long years of research and development.

If you need a special, custom-made valve, *look to Chapman* for help in its development, but be sure *first* to consult the Chapman Standard Line, because you may find there *the exact valve for your job.*

The Chapman Valve Manufacturing Co., Indian Orchard, Mass.



Dehydration and absorption units.

Magnolia's new Vanderbilt gasoline plant

By H. L. BAKER, *Assistant Superintendent*, Vanderbilt Natural Gas District,
Magnolia Petroleum Company

In the immediate prewar months of 1941 plans were under consideration for the construction of a casinghead gasoline plant on the Magnolia Petroleum Company's West Ranch lease near Vanderbilt, Texas. With the advent of war it was necessary to postpone construction plans pending availability of materials that were more urgently needed elsewhere.

Late in 1945 there was sufficient easing of supplies that the plans again could begin to materialize. Accordingly, specifications were prepared and sent to contractors for proposals. The goal, broadly, was the conservation and processing of casinghead gas and delivery of the residue gas to a gas pipe line for transmission to Beaumont for use as refinery fuel. It also aimed to utilize the gas from 13 high pressure gas wells, which would supplement this supply and make delivery at a rate of 50,000,000 to 60,000,000 cu ft a day feasible. The casinghead gas flared on Magnolia leases amounted to some 12,000,000 cu ft a day with an equal or greater amount flared by other operators in the field. In addition to processing the casinghead gas for its gasoline content, it was also found economically practicable to process the gas well gas, despite its very low gasoline content.

In any approach to the problem it was felt necessary, as a matter of economy, to utilize the mechanical installations already in operation on the property. This equipment consisted of 690 hp of compressor capacity used to gather some of the casinghead gas for use as fuel and injection into a producing formation as a conservation and pressure maintenance measure. There was also available 230 hp used for refrigeration in connection with the chillers, contactors, etc., for the gas pipe-line dehydration plant.

After consideration of the various approaches made by the several bidders, the contract was awarded to the Hudson Engineering Corporation of Houston early in 1946. Then began the long and tedious accumulation of materials and equipment that had to be on hand before construction could be started. This took considerable time as delivery of fittings, valves, piping, heavy vessels, engines, generators, motors, and other equipment was difficult to obtain.

Any plant such as this one is a combination of integrated, but still separate, processes; most of these are of a routine nature and will only be mentioned in passing with more elaboration being given to what may be called innovations or deviations from the usual procedure.

● **Gathering system.** The gathering system consists of 22 miles of pipe line, varying in size from 20-in. diam for the main lines down to 4-in. diam for lateral

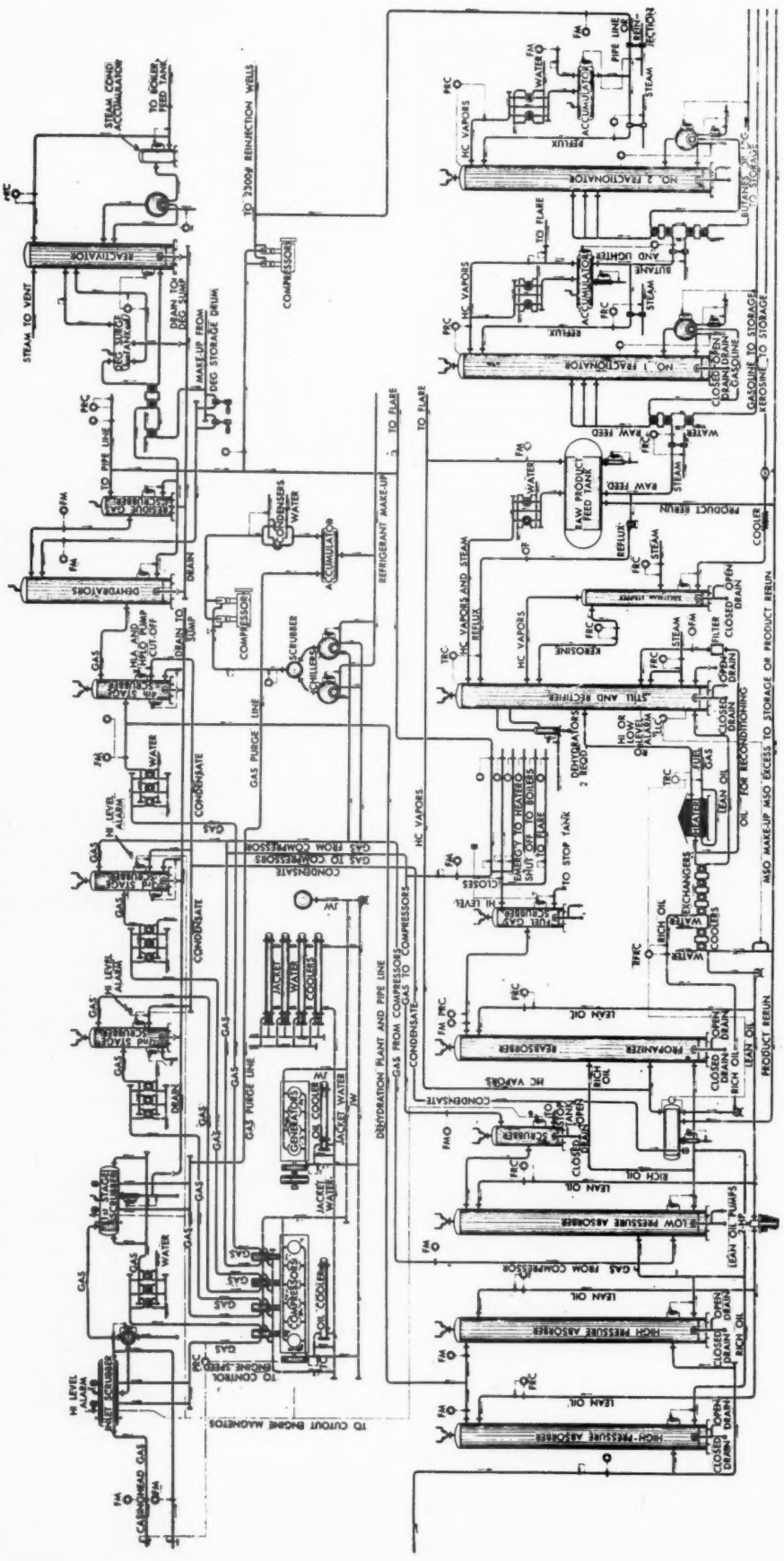
feeders, the pipe being so sized for the volume handled that the pressure at each gathering point will be atmospheric giving a high quantitative yield of gasoline from the gas and conserving some of the hydrocarbon vapors normally lost out of storage tanks. The installation of heater-treaters on all Magnolia batteries is also expected to increase the gasoline yield. The pipe used in the gathering system is of the spiral weld, thin wall type. A similar type parallel residue system, approximately 12 miles in length, provides for return fuel to outlying leases. As protection against corrosion (which is an ever-present problem and especially prevalent in the West Ranch field because of exposure in many places to tidal waters) the pipe was cleaned, primed, given a coat of hot enamel, wrapped with fiberglass, given a second coat of enamel, and finally wrapped with asbestos felt. This protective work was done mechanically in a central pipe yard and resulted in a coating approximately 3/32 in. thick. After welding and while the pipe was still on skids, the exposed areas around welds were given a hand applied coating equal to that applied in the yard. As a final inspection the pipe was checked by an electronic holiday detector, and any imperfections were hand patched. Except for special precautions to prevent damage to the protective coating, the field operations were of a routine nature.

● **Gas compression.** The only available outlet for the casinghead gas after processing is the gas transmission pipe line to Beaumont. In order to deliver this, it is necessary that it be brought up to pipe-line pressure; which is about 1000 psi. To obtain the maximum yield from the field gas the pressure at the separators (i.e. heater-treaters) has to be held at or near atmospheric pressure, which means that the plant suction has to be maintained at approximately 10-in. mercury vacuum. This suction pressure as compared with the 1000 psi discharge pressure involves four stages of compression. Although this is not necessarily an unusual procedure, it is a departure from normal casinghead gasoline plant practice and does involve an extraordinary expenditure for compressors in order to utilize all casinghead gas.

The machinery to gather and compress the gas consists of eight 1000-hp 2-cycle, V-type gas engines with five compressor cylinders mounted on each frame. These engines are supplemented by 460 hp of that previously mentioned as being a part of the original available equipment. The gas is taken by four stages of compression from 10-in. mercury vacuum at the first stage (2 cylinders per engine being used on this stage) and discharged at the fourth stage at 1000 psi. Approximately 25,000,000 cu ft can be handled per day by the engine-compressor units. Gas coolers are used after each compression and any liquid condensed by cooling is removed in scrubbers before the gas enters the next stage. The four stages of compression and resulting maze of piping, clearance bottles, etc., made an engine room basement almost a neces-

Flow diagram

VANDERBILT GASOLINE PLANT



Bigger Filters for BIGGER M·E·K PLANTS

THE advantages of fewer filter units installed in big M·E·K Lube Plants are:—

Lower installed cost
More time on stream
Lower operating costs
Less maintenance

The newest General American Conkey solvent dewaxing filter now being constructed is a BIG filter, General American's biggest to date — providing 625 square feet of filter surface in rotary drum 10' diameter by 20' long.

This large size is practicable due to the Conkey structurally ribbed rotary drum construction which adds size option to the many other advantages of its design.

Bulletin #104, now in preparation, will outline other advantages of this largest size filter unit. Write for your copy which will be mailed when available.

General American
TRANSPORTATION CO.
process equipment • steel and alloy plate fabrication
SALES OFFICE: 10 East 49th St., Dept. 900a, New York 17, N. Y.
WORKS: Sharon, Pa., East Chicago, Ind.
OFFICES: Chicago, Sharon, Louisville, Orlando, Washington, D. C. Pittsburgh, St. Louis, Salt Lake City, Cleveland.

GATX GENERAL AMERICAN

Other General American Equipment

TANKS . . .
Crude • Gasoline • Propane
Butane • Chlorine • Acid
Blending • Mixing Water
TOWERS
Absorber • Flash
Bubble • Pressure
Vacuum • Fractionating
DEWAXING FILTERS
STACKS • BINS
STEEL PLATE FABRICATION
WIGGINS ROOFS

General American Conkey Dewaxing filters installed in recently completed M.E.K. lube oil plant.

Standard Oil Company

Some highlights from the Annual Report for 1946, which has just been issued

The conduct of business and the welfare of people in general are closely related here in the United States. That is why we publish the following summary of this company's annual report to its 164,000 stockholders. Put as briefly as possible, here are the year's developments in our work which are of the broadest public interest.

Eugene Holman Frank W. Abrams

EUGENE HOLMAN
PRESIDENT

FRANK W. ABRAMS
CHAIRMAN OF THE BOARD

THE WORLD'S NEED FOR OIL in the postwar period is developing even more rapidly than was expected. Not only in the U.S. but world-wide, demand for oil products in 1946 was the largest in history, exceeding even the war years' period. The pressure of demand is being felt in all lines of the business.

AFFILIATES OF THE COMPANY are now operating practically at maximum capacity—a situation prevailing throughout the industry. Needed increases in output can be achieved only by enlarging every operation from well to market. In financing these activities, capital expenditure in 1946 reached the record figure of $279,000,000. The budget for 1947 provides for further increases. Construction of needed new facilities is one of the industry's major tasks for the immediate future.

NET EARNINGS accruing to the interest of Jersey shareholders represent a return of 11.12% on average net worth, or 10.80% on total income of the Company and its affiliates. Such consolidated earnings for 1946 came to $6.50 per share of outstanding stock, a total of $177,610,000. Net income for the parent Company was $3.83 per share, a total of $104,770,000. Dividends of $3.00 per share were paid by the Company during 1946.

OF TOTAL MONEY TAKEN IN from all sources by the Company and its affiliates, 64% was paid out for crude oil, other materials and supplies, maintenance, direct taxes, and similar necessary expenses.

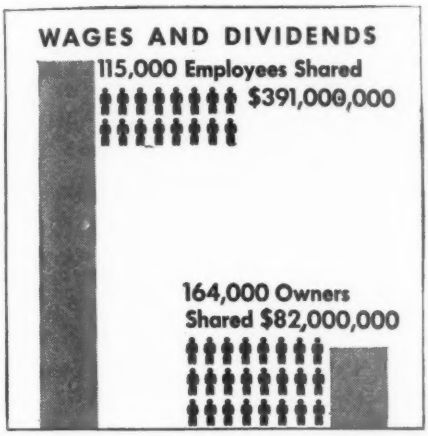
36% REMAINED after these expenses. Of this remainder, 65% was paid to 115,000 employees, 13% went as dividends to the Company's stockholders, 16% was held for use in the business, and 6% was the amount applicable to minority ownership of subsidiary companies.

INCREASED PRODUCTION AND SALES reflected the world's growing need for oil and its products. World-wide production of crude oil by Jersey affiliates increased 9.6% over 1945. Working at or near capacity, refineries of Jersey affiliates processed 7% more oil than in 1945—producing 9% of total U.S. petroleum products. Sales by affiliates also reflected rising need for oil. With relaxation of rationing, there has been increased use of oil products not only in this country but also in most of the foreign countries served by Jersey affiliates.

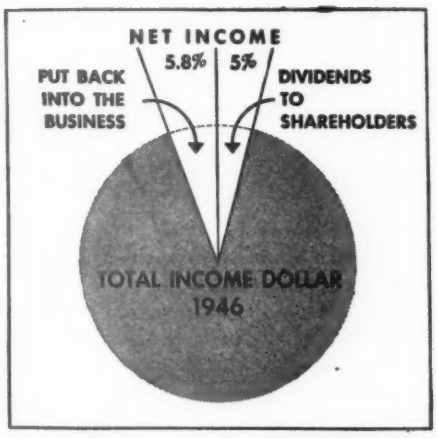
19 OCEAN TANKERS were purchased in 1946, in replacing tankers lost during the war. To promote greater safety at sea, three of our ships have now been equipped with radar and two more are being so equipped.

RESEARCH WORK during the year moved ahead, developing better and more versatile processes and products. Special attention was given to develop-

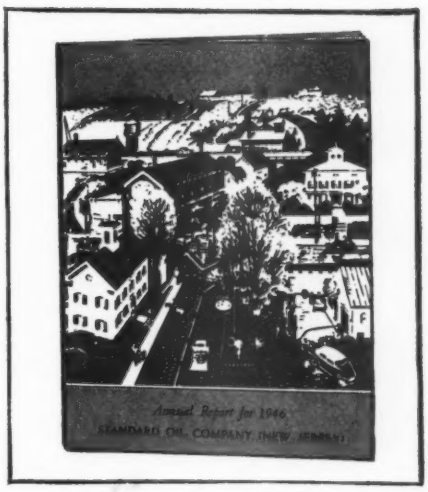
(New Jersey) reports...



EACH FIGURE REPRESENTS 6,975 PERSONS, and the bars represent the amounts of income each group received from Jersey in 1946. The sum of $391,000,000 was paid to employees of the Company and affiliates in wages, salaries and benefits. Dividends amounted to $82,000,000.



THIS SHOWS THE AMOUNT OF NET INCOME accruing to the interest of Jersey shareholders during 1946. It shows also the proportion paid to these shareholders in dividends and that left in the business to meet future capital expenditures, etc.

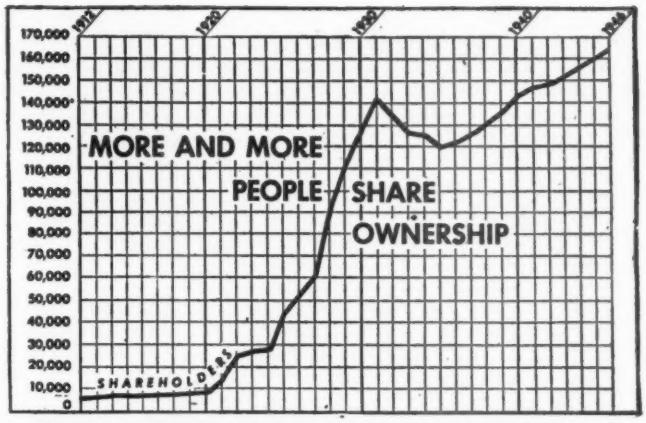


COPIES OF THE FULL REPORT are available on request. Address Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

ment of high octane gasolines to anticipate the requirements of coming higher compression automobile engines—giving greater power and increased miles per gallon. Semi-commercial conversion of both natural gas and coal into oil products has shown encouraging progress.

GOOD LABOR-MANAGEMENT RELATIONS during the year continued the Company's long record of industrial peace. There was no domestic strike or work stoppage during the year. 88% of former employees discharged from the armed services have returned to work for the Company. In addition, 11,577 veterans were newly employed by the Company. More than 78% of eligible domestic employees participated in the Group Insurance Program. Employees saved $17,615,000 in the Thrift Plan last year, to which their employers added $30,329,000.

LOOKING AHEAD, it is clear that if men, through science and machines, are to drive persistently toward better living standards for all people, vast quantities of oil must be found, brought to the surface, refined, and distributed to all parts of the world. Standard Oil Company (New Jersey) is increasing substantially its activities and investments abroad as well as in this country. These are practical demonstrations of our confidence that American enterprise can help meet the needs of people everywhere and thereby serve the cause of lasting peace.



WIDENING OWNERSHIP OF NEW JERSEY is shown by the fact that the number of shareholder accounts has increased from 5,816 in 1912 to 164,000 as of December 31, 1946.

STANDARD OIL COMPANY (NEW JERSEY)

AND AFFILIATED COMPANIES

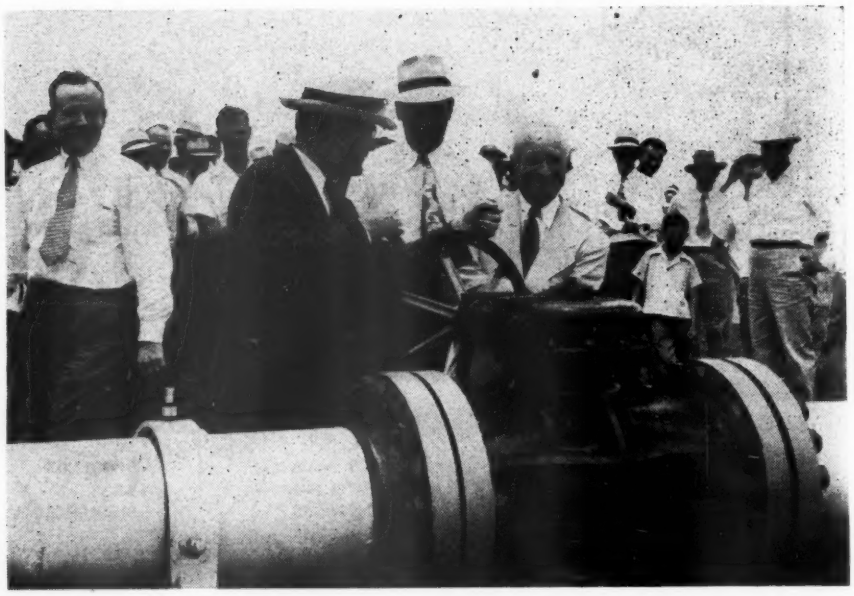
sity as well as a convenient place for the location of accessory engine equipment such as lube oil filters and coolers. The suction and discharge headers are conveniently placed alongside the engine room with walkways giving access to the control valves. As a matter of interest, the field suction header is 42 in. in diam, which practically puts it in the tunnel class. All gas headers and piping, where practicable, are above ground, being mounted on massive concrete piers and clamped to prevent and damp vibration.

One of the design features of the plant is that the casinghead gas is processed through absorbers at 325 psi between the third and fourth stages of compression. Processing at this pressure and subsequent withdrawal of all gas needed for fuel and the shrinkage in volume due to removal of the gasoline results in some 6,000,000 to 8,000,000 cu ft less volume per day to be handled by the fourth stage compressor and a very material saving in overall compressor horsepower requirements, which is actually some 500 hp or one-half of an engine. This reduction in horsepower requirement plus the use of 460 hp of existing equipment, eliminated one entire 1000-hp compressor from equipment required for the plant.

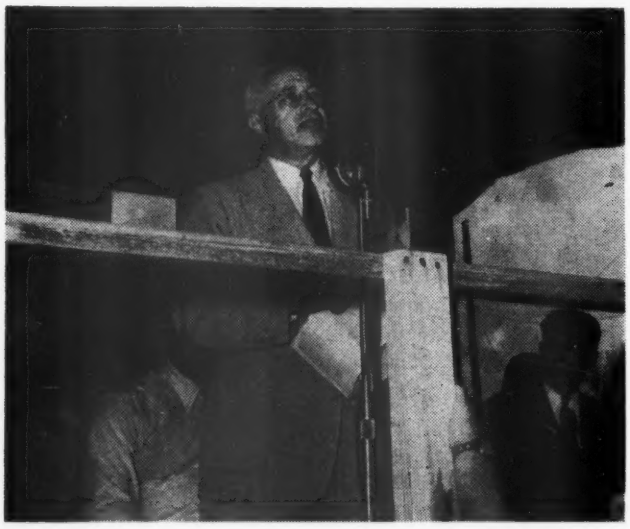
● **Gas cycle.** The plant has two main sources of gas: (1) Casinghead gas from oil producing wells, and (2) gas from the high pressure gas wells. Likewise there are two absorption systems: (1) The low pressure system operating at 325 psi, which handles the casinghead gas delivered between the third and fourth compressor stages as previously mentioned, and (2) the high pressure system at 1000 psi, which takes gas directly from the gas wells. The two systems are essentially the same except for the difference in operating pressure. In operation the high pressure gas wells are allowed to "float" on the line. Only that which is necessary to supplement the casinghead gas to meet the gas pipe line demand is withdrawn.

The gas to the low pressure absorber is passed through the chillers mentioned earlier as part of the original equipment available for use in the new plant. Chilling of the gas effects a considerable lowering in the absorption oil rate, fewer gallons per minute being required for the same gasoline extraction efficiency.

The gas leaves the 325-psi absorber (there are some 17 to 19 million cu ft per day in excess of fuel requirements) and goes to the fourth stage compressor where it is brought up to the pressure of the well pressure gas leaving the 1000-psi absorber. The two gas streams combine at this point and enter the dehydration towers. Diethylene glycol, which is soluble in water in all proportions and has the additional property of selective removal of water vapor from hydrocarbon vapors, is used as the dehydrating medium. Sufficient water vapor is removed to reduce the dew point well below minimum temperatures encountered in the pipe line. After dehydration the gas enters the pipe line at the rate of

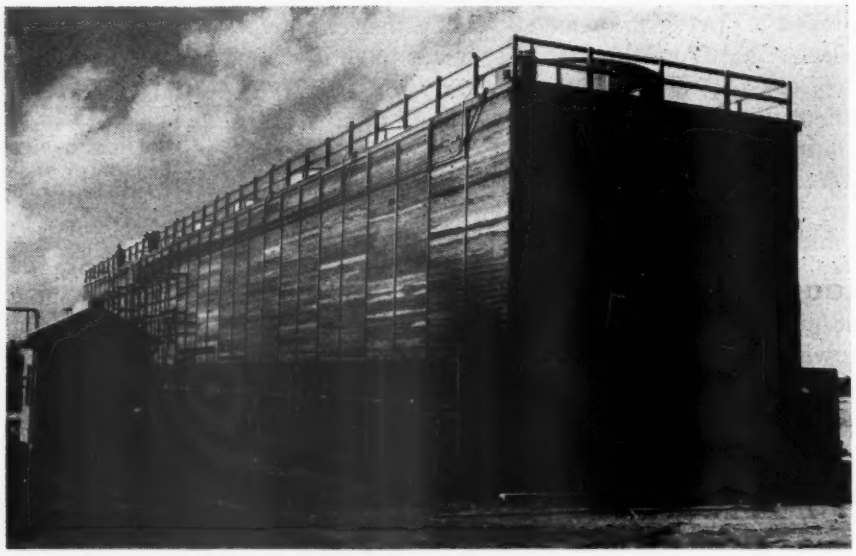


At dedication ceremonies, Colonel Ernest O. Thompson, chairman of the Texas Railroad Commission, opens a valve that puts residue gas into the Beaumont pipe line and at the same time snuffs one of the field flares. In the picture, left to right, are: R. D. Hanley, manager, Natural Gas Department, Magnolia; Colonel Thompson; E. E. Campbell, district superintendent, Vanderbilt Natural Gas District, Magnolia Petroleum Company, and R. M. Chan, vice president, Magnolia.



R. M. Chan, vice president, Magnolia Petroleum Company, addressing crowd at dedication ceremonies.

Forced draft cooling tower.



A well-known family in medieval Italy, the Borgias, were reputed to have used certain chemical formulas with startling effects . . .

Certain chemicals, in more or less general use for years, are capable of transforming an ordinary tomato into a gorgeous "strawberry". . .

EFFECTIVE Chemicals

From this source are derived certain aromatics capable of producing great effort and movement away therefrom . . .

Acetyl salicylic acid, frequently found effective for general pain, headaches and hangovers . . .

WHEN YOU HAPPEN TO HAVE an emulsion "headache," the fastest relief you can get comes in the red Tret-o-lite drum. Just grab the phone and call a Tretolite Company engineer—located near every oil field—they have just the right medicine for your emulsion problem.

COMPLETE SERVICE FOR EVERY FIELD

TRETOLITE COMPANY

Manufacturing Chemists

ST. LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

DEHYDRATING DESALTING

47-F

Distillation and fractionation equipment under construction.

50-60 milion cu ft a day under sufficient pressure to deliver it to Beaumont some 200 miles away without additional boosting in transit.

● **Propanizer-reabsorber.** An unusual adjunct to both the absorption and distillation systems is the inclusion in the plant of a tower known as a propanizer-reabsorber. This is a process developed by the designer whereby in an automatic cycle the butane-propane recovery is materially increased without increasing the oil circulation and the total rich oil stream is conditioned, prior to its entry into the still, to decrease the amount of absorbed, undesirable methane. This is accomplished by stripping the rich oil with a high propane-butane content gas, i.e. uncondensed vapors from the still accumulator. The stripping action removes methane from the oil and substitutes propane and butane. Each gallon of methane so removed is replaceable by approximately 24 gal of propane or 71 gal of isobutane. The volume of gas stripping medium required is completely self regulating and requires no controls. If the quantity of uncondensed vapors from the still increases, there is increased stripping in the tower thus reducing the quantity of uncondensed vapors entering the still. Conversely, if the still overhead contains insufficient light ends to maintain the still pressure, no vapors flow to the propanizer and there is no stripping until more light hydrocarbons enter the still and the system rebalances itself. A further accessory to the still is a small vessel known as a side stream stripper to produce a naphtha or kerosine fraction depending on demand.

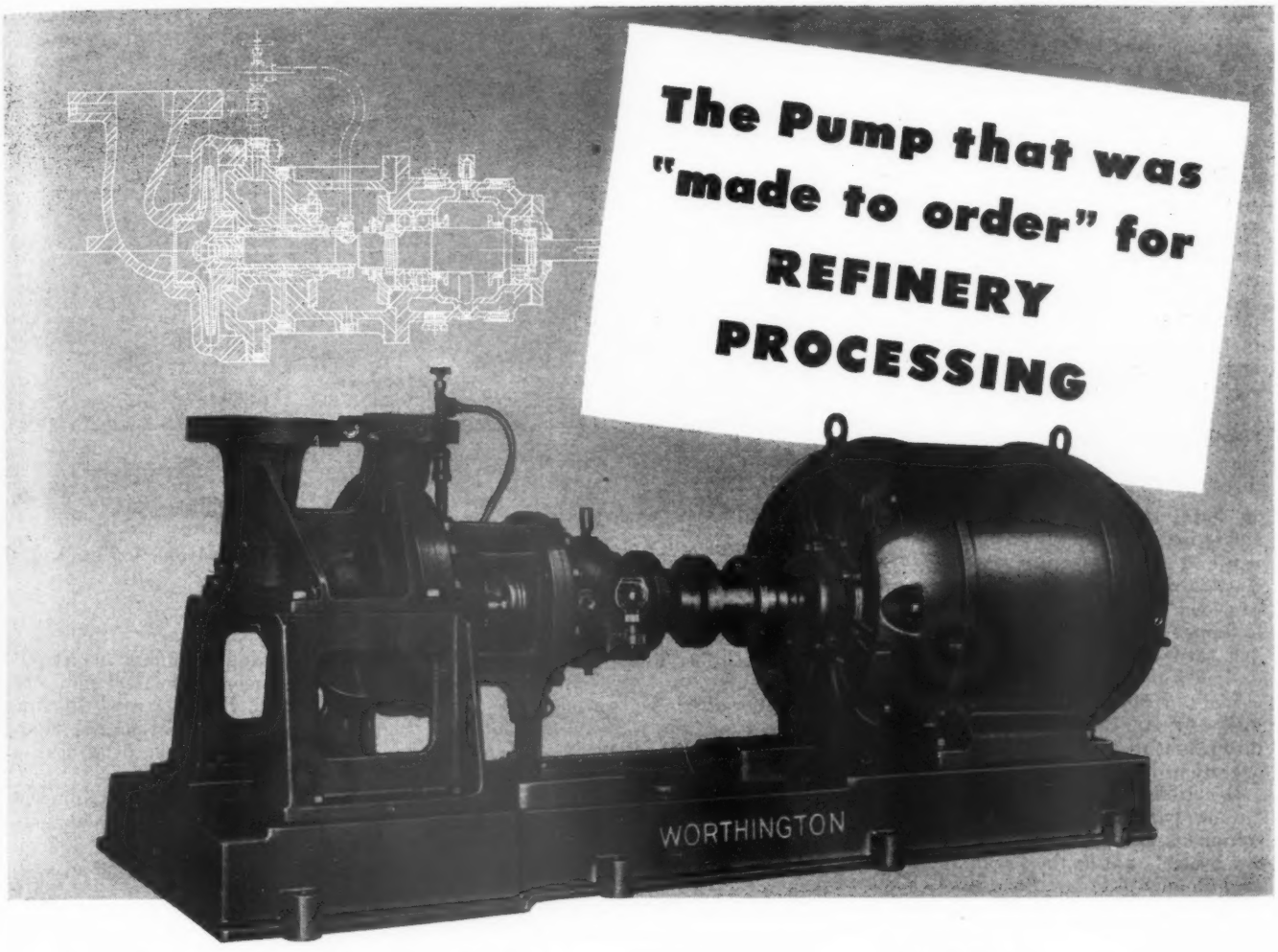
● **Fractionation.** The hydrocarbon vapors removed from the oil in the distillation column are liquefied by condensation. The accumulated liquid containing some objectionable light fractions is then pumped to the fractionating plant where by selective fractionation the undesirables are removed and rejected to the fuel system and the desirable portions separated into their commercial products. At the present there are two fractionators. One produces natural gasoline of approximately 26-lb Reid vapor pressure and the other delivers a butane mixture or a vapor pressure LPG as a bottom product. A third column is planned for a future date that will allow for separation of the propane and ethane for delivery as separate liquid products.

● **Electrical generating equipment.** Electrically driven centrifugal pumps are used throughout in the plant operations. Power for these pumps as well as for the cooling tower fans and plant lighting is generated by four 8-cylinder, 4-cycle gas engines driving 375-kva generators. Provisions have been made for additional generator units in the event of an increase in plant or field requirements.

● **Water supply.** It is evident that the many plant processes necessitate considerable quantities of water for cooling and condensing equipment. All that is needed is supplied from two deep artesian wells on the plant property. The water is very soft, which is unusual for well water along the Gulf Coast; however, it contains large amounts of carbonates that are particularly objectionable in boiler feed water and, in concentration, complicates cooling tower operations unless some form of water treating method is used.

● **Water treatment.** The cooling tower is 24 ft wide, 192 ft long, and 30 ft high, and is of the induced draft type. Eight fans, 14 ft in diam, driven by 25-hp motors are mounted in cells atop the tower to provide the necessary air circulation. As the water flows into this tower, it is treated by direct injection of concentrated sulphuric acid. The carbon dioxide liberated by this reaction is dissipated inside the tower. Some 36 gal of acid are required daily to treat the quarter of a million gallons of raw make-up water needed to replace that lost by evaporation and blow-down. The use of such quantities of sulphuric acid for water treatment is a rather drastic procedure. Properly controlled, however, this method has proved to be most satisfactory and economical. Further treatment to control algae growth, always a problem in this climate, is provided by direct proportional injection of liquid chlorine.

Water for the two 200-hp 3-drum water-tube boilers requires a somewhat more complete treatment than is needed



Every feature of the Worthington HR Centrifugal Pump has been carefully designed to meet the special needs of petroleum processing. Liquid passages, impellers, shaft sleeves, bearing assemblies, cantilever shafts and stuffing boxes are all custom-built to refinery requirements.

VERSATILE!

Both the single-stage HR and two-stage HB, for higher heads, are available in a variety of materials for different temperature, pressure or corrosive conditions. (See panel below.) And both have the low N.P.S.H. characteristics so desirable for handling volatile liquids.

IN WORLD-WIDE USE

A typically successful example of Worthington's specialized engineering, the hard-working, economical HR is standard equipment in leading refineries the world over . . . striking proof that *there's more worth in Worthington.*

For full details, contact our nearest District Office. Or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N.J.*

For Your Convenience

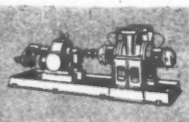
Field stocks of HR's are kept in Tulsa and Los Angeles.

WORTHINGTON

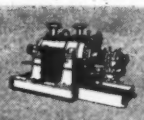
THE WORLD'S LARGEST MANUFACTURER OF PUMPS

C7-4

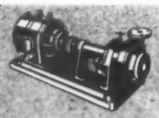
Types HR and HB. Twenty sizes. Capacities up to 1800 g.p.m. Developed heads up to 900 ft. Proper selection of material permits use for temperatures far below zero to 800°F., for pressures from high vacuum to 750 lb. per sq. in. gauge.



Type HD. Hydraulically-balanced, double-suction impeller handles boiling liquids with low submergence. Capacities range from 600 to 3200 g.p.m. at heads up to 700 ft., temperatures up to 850°F., pressures up to 550 lb.



Type WH. High-pressure, high-temperature, centrifugal hot-charge pumps. Twelve distinct points of superiority, based on years of experience building pumps for high pressures and temperatures. Capacities to 8000 g.p.m., heads to 5000 ft.



Type NL. Several construction arrangements permit flexibility in application. Designed for temperatures up to 225°F., or higher with water-jacketed stuffing box. Capacities up to 1600 g.p.m., heads to 500 ft.

for the cooling tower water. The boiler feed water is treated by the hydrogen zeolite process, which is also known as a cation exchanger. The process is similar to the familiar sodium zeolite treatment except that the hydrogen ions are exchanged rather than the metallic ions and calcium carbonate is converted to highly unstable hydrogen carbonate that breaks down into water and carbon dioxide. The carbon dioxide is removed and vented in a deaerator and the metallic calcium ion is absorbed on the synthetic resinous material of the zeolite bed. Regeneration of the zeolite is accomplished by back-washing with dilute sulphuric acid. As a final and complete conditioning of the boiler water, sodium phosphate and sulphite are added as a threshold treatment.

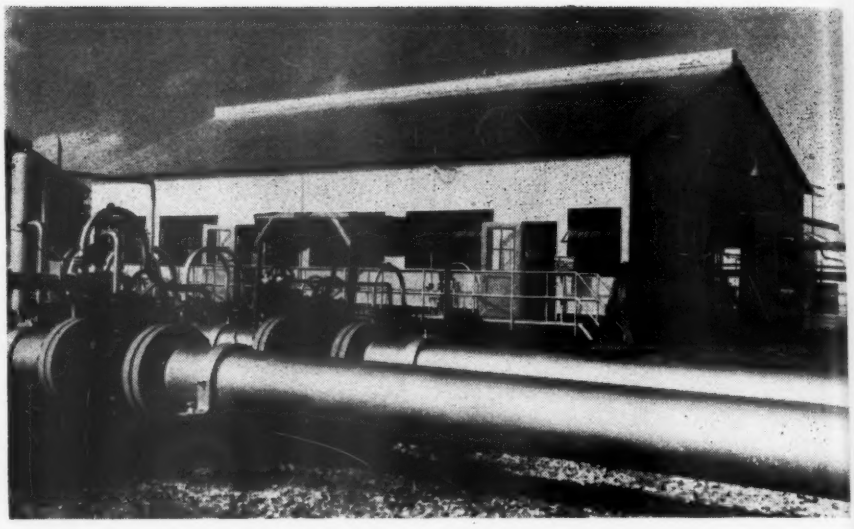
● **Safe operating features.** Every consideration was given in planning a convenient and safe operating plant. Change rooms, showers, and lockers are provided for the plant personnel. All buildings are well ventilated and lighted and yard and process area lighting are designed to eliminate hazardous dark corners. Unobstructed, covered sidewalks or steel walkways give access throughout the plant. So far as possible operations have been made automatic.

Recording instruments and controls are on panel boards adjacent to the equipment and all motors and push button controls are of the latest approved explosionproof design. Steel safety cage ladders lead to all railed elevated operating platforms and all moving equipment is protected by guards. Ample capacity extinguisher type fire fighting equipment is placed in accessible, strategic locations and an auxiliary gasoline engine fire pump serves fire mains and hose systems throughout the yard, loading, and storage areas. Automatic alarms and fuel shutdowns are provided for the heater and boilers in case of feed pump failure. A magneto grounding system stops the engines in the event of high levels in scrubbers and similar controls are installed for certain vital pumps and supply systems. In addition there are remotely operated emergency shut-down switches by which the heater and boiler fires may be snuffed and engines stopped in the event fire or explosion should make it impossible to reach those areas.

● **Foundations.** The foundations of all towers and equipment were designed to carry loads not to exceed 2000 lb per sq ft and to be sufficiently massive so that guys are not needed to withstand any probable hurricane wind velocities, which in this area have exceeded 100 mph. This fact plus the poor character of the subsoil made it necessary to have unusually deep excavations and large, heavily reinforced footings for all equipment.

☆ ☆ ☆

An American-made oil refinery with a capacity of about 14,000 bbl per day, or 470,000 tons monthly, has been purchased by a Swedish concern to be erected in Gothenberg by 1948.



A part of the new plant; pressure maintenance facilities in background.

● **Laboratory.** A plant laboratory provides all facilities for routine plant control and products testing. Major control problems and analyses of gas, products, and water are handled by the Dallas laboratory of the company's Natural Gas Department.

● **Statistical data.** As a matter of statistical information some 2200 yards of concrete were used for the compressor blocks, the supporting monolithic mat, and the engine building. An additional 2600 yards were used for foundations of the various towers, vessels, and miscellaneous equipment. More than 7000 yards of earth were moved for foundations and necessary grading.

A total of 8460 engine hp are used for gathering and compressing gas and 1500 engine hp generates the needed electric power for pumps and lighting. There are 230 engine hp used for injecting gas in the Greta producing formation, and 230 engine hp provides refrigeration for cooling. The water rate over the cooling tower exceeds 7,000,000 gal per day, more than half a million gallons of absorption oil are recirculated every day, and more than 3,000,000 cu ft of gas are used for plant fuel.

Performance specifications of the plant call for not less than 98 per cent extraction of isopentane and heavier and not less than 90 per cent extraction of the normal butane contained in the inlet casinghead gas. An extraction of 90 per cent of the isopentane and heavier is required of the high pressure gas wells producing from the Marginulina and Menefee formations. The residue gas streams from the primary absorbers and reabsorbers are held at or below 0.02 mol per cent and 0.03 mol per cent of hexanes and heavier respectively, which indicates very efficient stripping.

● **Products manufactured.** Although only two fractionating towers are installed at present, their design is such as to give maximum flexibility. Any one of the following combinations can be produced as market demand indicates:

(a) A 26-lb RVP natural gasoline and a mixture of iso and normal butane containing not more than 5 per cent of other hydrocarbons.

(b) A natural gasoline containing not more than 3 per cent butanes and a mixture of iso and normal butane containing not more than 5 per cent of other hydrocarbons.

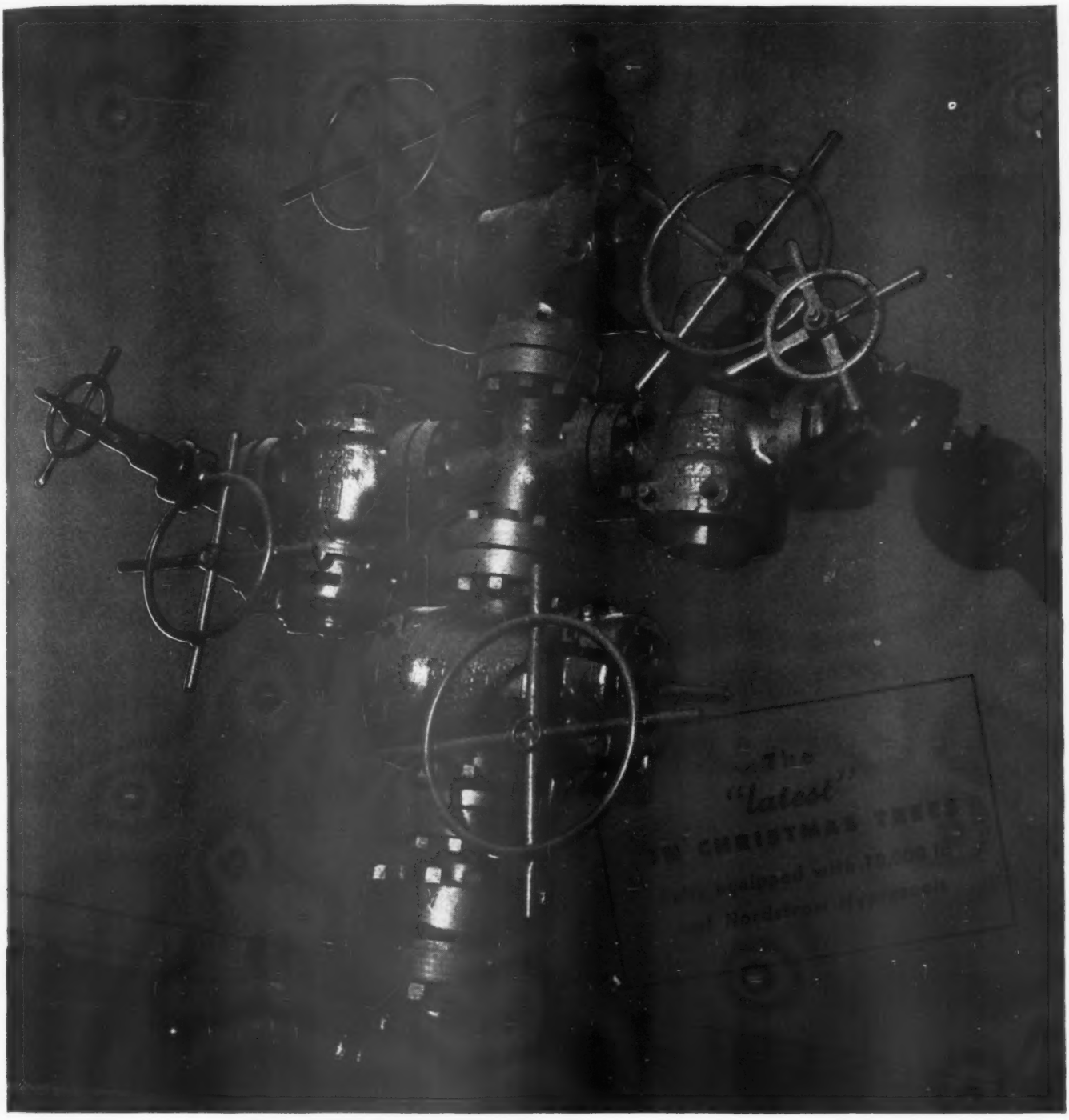
(c) A natural gasoline having a 26-lb RVP, and a mixture of butanes and propane having a vapor pressure of 100-lb gauge.

(d) A natural gasoline containing not more than 3 per cent butanes and a mixture of butanes and propane having a vapor pressure of 100-lb gauge.

In addition to the above products, there is a distillate, i.e. kerosine, product from the condensate of the high pressure gas wells produced as a side stream from the still. This product has a boiling range of approximately 360-500 F.

Daily production of the plant on the present gas approximates 33,000 gal of 26-lb RVP gasoline, 6500 gal of LPG, and 1500 gal of kerosine. The casinghead gas, as mentioned before, processed by the engines amounts to some 25,000,000 cu ft a day and the high pressure gas to some 25-40,000,000 cu ft a day, depending on the gas pipe line requirements.

● **Product disposal.** All gas processed, other than local fuel needs, is delivered to the gas pipe line. The casinghead gasoline not exceeding 26-lb RVP may be delivered into the company's crude oil pipe line. A 16-car loading rack and a truck loading rack each equipped with vapor return lines provide for shipment of LPG, kerosine, and also gasoline by truck or rail as the occasion may demand. Any excess propane and lighter liquid product over market requirements is returned, by means of an injection pump, to a producing formation for storage as a conservation measure. ★ ★



At Katy, Texas, this stalwart Christmas Tree, controlling a cycling well, reflects the most modern design for high pressures. These 10,000 lb test Hypreseal valves insure absolute safety.

Nordstrom
LUBRICATED VALVES

NORDSTROM VALVE DIVISION — *Rockwell Manufacturing Company*

Main Offices: 400 North Lexington Avenue, Pittsburgh 8, Pa., Atlanta, Boston, Chicago Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa

. . . and Leading Supply Houses

Export: Rockwell International Corporation, 7701 Empire State Bldg., New York 1, N. Y.

Control of mud properties in drilling anhydrite*

By GEORGE R. GRAY†

For many years, anhydrite (native anhydrous calcium sulphate, $CaSO_4$) has been recognized as a major source of trouble in drilling operations in some areas. Numerous instances of stuck pipe and expensive fishing operations bear witness to the difficulties engendered by peneration of beds of anhydrite. As will be discussed later, the most serious effect of anhydrite on the drilling mud is the production of a marked increase in filtration, or water loss to the exposed formations, with resulting sloughing of shales and deposition of a thick cake of mud solids on the face of permeable beds. The use of such high-water-loss mud may result in stuck drill pipe and flooding of productive sands. The cost of a completed fishing job can be estimated accurately but the loss resulting from impaired production in consequence of the invasion of the oil-bearing formation by water from the drilling mud usually cannot be evaluated.

One region in which drilling operations have been plagued by anhydrite is the North Louisiana-South Arkansas-East Texas area. In the Ark-La-Tex area, anhydrite is found in two principal formations, the Glen Rose and the Buckner. The Glen Rose anhydrite is from 250 to 300 ft thick in East Texas. The anhydrite thins out in North Louisiana and disappears in Columbia County, Arkansas. The Buckner anhydrite is variable in thickness over the area, ranging from 30 to 250 ft.

That anhydrite has been a major problem in controlling mud properties in the Tri-States area is evident from an examination of Fig. 1, which shows the average water loss of all muds tested by Baroid field service engineers in that area during the period 1941 through 1945. The arithmetic averages for periods of three months are shown. Between 100 and 600 tests were made in each period. The two abrupt drops in the average volume of filtrate resulted from the introduction of two methods of overcoming the ill effects of anhydrite, which will be discussed in detail later.

● **Effect of anhydrite on mud.** Although anhydrite is only sparingly soluble in water, the deleterious effects on the mud resulting from drilling thin streaks is evident as soon as mud carrying anhydrite reaches the surface. There is an increase in viscosity and in initial gel strength that gives the mud a characteristic fluffy appearance. As the flocculation of the clay solids progresses, viscosity may drop to below that of the original mud. Water loss shows a marked rise and there is a corresponding increase in cake thickness. Initial and 10 minute gel strengths become equal (flat gels"). The pH is lowered.

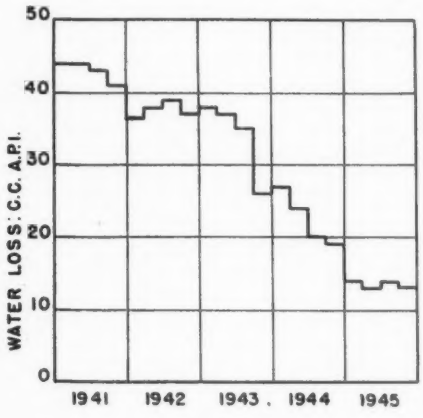


FIG. 1. Average water loss of muds. Muds used in Arkansas-Louisiana-Texas area.

These changes are evident from a study of Table 1 in which is shown the effect of anhydrite on the properties of a native shale mud from Smith County, Texas. That the calcium ion is responsible for the undesirable changes in mud properties might be inferred from the analysis of the mud filtrate. There is an increase in concentration of both the calcium ion and the sulphate ion but the concentrations of the two ions do not increase to the same extent in the filtrate because a part of the calcium is held by the clay particles.

● **Unsuccessful attempts to control anhydrite contamination. Alkalies and quebracho.** Soda ash (Na_2CO_3) and quebracho, or caustic soda ($NaOH$) and quebracho, or all three together, have been used for a number of years in attempting to overcome the effect of anhydrite. Bentonite and water are usually added along with the chemicals. Common practice has been to add about 200 lb of caustic soda and 200 lb of quebracho per tour while drilling anhydrite.

Water is added, along with 15 to 20 sacks of bentonite. By this treatment, water loss can be kept between 25 and 50 cc. If only a small amount of anhydrite is present, such treatment may be satisfactory. If thick beds of anhydrite are drilled, however, the effectiveness of the chemical treatment appears to decrease. The reaction product, sodium sulphate, accumulates in the mud and tends to flocculate the clay colloids. The problem then becomes one of replacing the coagulated colloidal material by fresh bentonite. Satisfactory control by this means is generally impractical and much effort and material is expended to barely get by.

● **Phosphates.** Orthophosphates and polyphosphates, separately and in various combinations, have been used with indifferent success in treating muds contaminated by anhydrite. Illustrating the behavior of the phosphates, Table 2 shows the effect of a mixture of equal parts of disodium orthophosphate (Na_2HPO_4) and sodium tetraphosphate ($Na_6P_4O_{13}$) on the mud from Smith County, Texas, the properties of which were given in Table 1. Water loss is reduced to that of the original mud by the addition of an amount of phosphate equal to the anhydrite present. Other properties of the treated mud are not so satisfactory. High gels are particularly noticeable in the sample treated with 10 lb of anhydrite and an equal quantity of phosphate. A similar result is commonly observed in the field. Analysis of the filtrate, showing an increase in sulphate-ion concentration, gives evidence of the accumulation of sodium sulphate in the mud and affords an explanation for the observed behavior.

Common practice in employing phosphates is to add 200 to 300 lb per tour, along with 10 to 20 sacks of bentonite and enough water to control the viscosity. Water loss is rarely less than 20 cc.

TABLE 1. Effect of anhydrite on mud from well in Smith County, Texas.

	Original mud	After adding anhydrite, 5 lb/bbl
Weight, lb/gal	9.8	9.8
Viscosity, cp	13	12
Initial gel, g	3	17
10-min gel, g	30	20
pH	8.6	7.9
Water loss, API, cc	21.0	69.0
Cake, 32nd of an in.	3	8
Analysis of filtrate:		
Calcium, epm†	0.2	24
Sulphate, epm	3.3	78

†Equivalents per million.

TABLE 2. Treatment of anhydrite mud with phosphates using mixture of equal parts NA_2HPO_4 and $NA_6P_4O_{13}$

Anhydrite added, lb/bbl	5	5	5	5	10
Phosphates added, lb/bbl	0	2.5	5	7.5	10
Viscosity, cp	12	6	8	14	30
Initial gel, g	17	2	2	5	30
10-min. gel, g	20	60	85	90	60
pH	7.9	6.9	6.7	6.6	6.4
Water loss, API, cc	69.0	26.0	22.0	19.0	20.0
Cake, 32nd of an in.	8	5	4	4	4
Analysis of filtrate:					
Calcium, epm	24	0.8	0.5	0.1	0.1
Sulphate, epm	78	105	148	210	350

*Presented at Drilling Fluids Conference, Texas A. & M. College, College Station, May 13-15, 1946.

†Manager Houston Laboratory, Baroid Sales Division, National Lead Company.

A HABIT TO JOE...

"NEW IDEA" TO HIS NEPHEW

...YET BOTH WANT THE SECURITY your P.S. Plan Provides

HAVE YOU told all your new or recently hired employees about the benefits of the Payroll Savings Plan for the regular purchase of U. S. Savings Bonds? Wage earners, according to a recent nation-wide survey, want security more than anything else. They prefer security to big pay, soft jobs, authority, "success."

There is no surer way to this peace of mind than systematic savings. And what surer, safer, better means can your employees find than payroll allotments for U. S. Savings Bonds? Bonds that return $4 at maturity for every $3 they invest!

Your active support of the Payroll Savings Plan is an investment in employee contentment, in the citizenship of your community, and in the security of America's future. This is practical "employee relations" of the highest type and pays dividends of satisfaction to everyone.

Start a drive today for larger participation in the plan. Many employees may be unfamiliar with its advantages. If you want literature for distribution, contact your State Director of the Treasury Department's Savings Bonds Division.

New Savings Bonds Plan won't affect the P.S.P.

THE Treasury Department and the banks of America are making it possible for farmers, doctors, and other self-employed people to participate in "automatic" Bond buying by special arrangement with their banks. This extension of the Savings Bonds program is not a partial payment plan and is intended *only* for people who are not in a position to take advantage of the Payroll Savings Plan.

The Treasury Department acknowledges with appreciation the publication of this message by

THE PETROLEUM ENGINEER

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

● **Control of anhydrite by chemical means.** In the preceding section it was pointed out that the addition of a substance that would precipitate calcium did not necessarily afford a satisfactory solution to the problem of anhydrite contamination because of the injurious effects of soluble products of the reaction.

Barium carbonate ("Anhydrox")* affords a means of removing calcium sulphate in its entirety, according to the reaction:

$BaCO_3 + CaSO_4 \longrightarrow BaSO_4 + CaCO_3$. Both of the reaction products are practically insoluble.

For purposes of comparison, the chemical reactions involved in treatment with soda ash, disodium orthophosphate, and barium carbonate, and the solubilities of the various salts, are given in Table 3. Solubilities are expressed in lb per 42 gal of pure water and may differ somewhat from the values in mud filtrates, which contain varying amounts of other soluble salts.

TABLE 3. Reactions between anhydrite and some treating agents and solubilities of the salts expressed as lb per bbl of water.

Soda ash:

$CaSO_4 + Na_2CO_3 \longrightarrow CaCO_3 + NA_2SO_4$

1.0 67 0.005 168

Disodium orthophosphate:

$CaSO_4 + Na_2HPO_4 \longrightarrow CaHPO_4 + Na_2SO_4$

1.0 109 0.7 168

Anhydrox:

$CaSO_4 + BaCO_3 \longrightarrow CaCO_3 + BaSO_4$

1.0 0.008 0.005 0.001

The effect of Anhydrox on a mud contaminated by anhydrite is shown in Table 4. Note that very little improvement in mud properties is evident until an amount of Anhydrox equal to 1.5 times that of the anhydrite has been added. Values for water loss and gels then return to those of the original mud (Table 1). The quantity of anhydrite carried by the mud is immaterial, so long as sufficient Anhydrox is added to react with it. (Compare column 5 in Table 2 with column 5, Table 4). There are no ill effects resulting from an accumulation of soluble products of the reaction. Analysis of the filtrate shows both calcium and sulphate removed.

Instead of allowing the mud to become badly contaminated by anhydrite, with the resulting high water loss and associated difficulties in drilling, far better practice is to treat the mud with Anhydrox just before the anhydrite is encountered and to continue the addition at such rate as to keep the mud in good condition at all times. Because of its limited solubility, an excess of Anhydrox does not bring about any undesirable changes in mud properties. It is advantageous to drill into the anhydrite with a low-water-loss mud, thereby reducing the possibility of caving if the section is broken by shale streaks.

TABLE 4. Treatment of anhydrite mud with Anhydrox.

Anhydrite added, lb/bbl	5	5	5	5	10
Anhydrox added, lb/bbl	0	2.5	5	7.5	15
Viscosity, cp	12	12	11	6	8
Initial gel, g	17	15	12	0	0
10-min. gel, g	20	20	20	25	25
pH	7.9	8.0	8.1	9.3	9.2
Water loss, API, cc	69.0	64.5	61.8	20.0	22.5
Cake, 32nd of an in.	8	8	8	3	4
Analysis of filtrate:					
Calcium, epm	24	17	11	0.1	0.1
Sulphate, epm	78	68	60	2.7	0.5

*U. S. Patent 2,393,165 R. W. Hoeppel, Assignor to National Lead Company. "Anhydrox" is the trade name for $BaCO_3$ marketed by Baroid Sales Division, National Lead Company.

The preferred practice in the Tri-States area is to add 15 to 25 sacks (100 lb per sack) of Anhydrox over a period of one circulation at the time the first stringer of anhydrite is drilled. Upon drilling into the massive anhydrite, Anhydrox is added at the rate of 2 to 4 sacks per hour while drilling the entire section. After the massive anhydrite has been drilled, a few additional sacks may be required to take care of stringers or of fine cuttings in the mud pits. Although the quantity of Anhydrox needed varies with the size of the hole, degree of consolidation of the anhydrite, efficiency of screens in removing cuttings, and other factors, on the average, 60 to 70 lb of Anhydrox are required per ft of anhydrite drilled.

The reaction between Anhydrox and anhydrite is retarded or prevented entirely by the presence of polyphosphates in the mud. Consequently, polyphosphates should not be used in thinning mud that is to be treated later with Anhydrox. If the mud has been thinned with polyphosphates, tests should be made on a small sample to determine whether the phosphate is still present in sufficient concentration to interfere with the action of the Anhydrox. Caustic soda-quebracho mixtures should be used to thin muds to be treated with Anhydrox. Extremely high concentrations of quebracho may retard the reaction in similar manner to the polyphosphates, and, if overtreatment with quebracho is suspected, a pilot test should be made before Anhydrox is added to the entire mud.

TABLE 5. Mud materials used in drilling anhydrite section, offset wells, Tremont field, Louisiana, 5800-6600 ft.

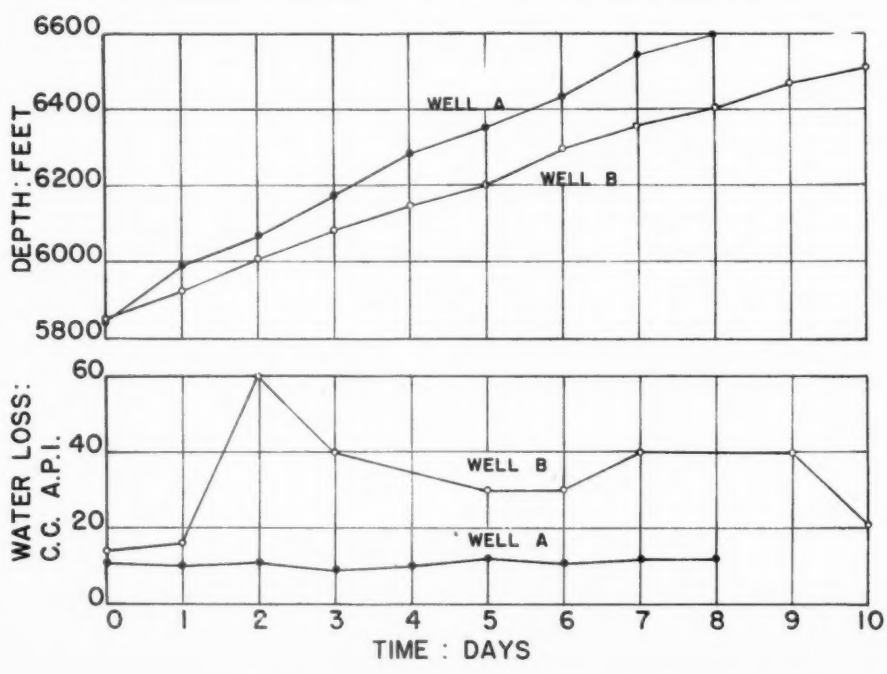
	Well A	Well B
Anhydrox, 100-lb sacks	168	0
Sodium acid pyrophosphate, lb	0	5800
Caustic soda, lb	300	0
Quebracho, lb	950	300
Aquagel, 100-lb. sacks	125	184
Cost of mud	$2100	$1600

A representative comparison of the effectiveness of Anhydrox and of polyphosphates is afforded by records of offset wells drilled in the Tremont field, Caldwell Parish, Louisiana. Fig. 2 shows the drilling progress and water loss of the mud while the Glenrose anhydrite section was being drilled. The first stringer of anhydrite was encountered at about 5900 ft. Between 5900 ft and 6360 ft, anhydrite stringers occurred in shale. Massive anhydrite was drilled from 6360 to 6460 ft.

Mud in Well A was treated with Anhydrox; sodium acid pyrophosphate was used in Well B. Materials added to the mud while drilling the interval shown in Fig. 2 are given in Table 5.

Although the cost of materials added to the mud in Well A was higher than

FIG. 2. Comparison of performance of (A) Anhydrox-treated mud with (B) phosphate-treated mud in drilling anhydrite.



for Well B, mud in Well A was maintained in good condition at all times, which made possible the drilling of the section in two days less time than was required for Well B, in which the condition of the mud was never satisfactory until after the anhydrite had been drilled. The saving in drilling time effected by satisfactory control of mud properties resulted in this instance in a net saving of approximately $1500.

In some areas, anhydrite or gypsum occurs in shale as veinlets ½ to 1 in. thick and in joint planes, bedding planes, and fractures. Native mud made from such formations shows the characteristics of anhydrite-contaminated mud, as may be seen in Table 6, which shows in column 1 the properties of a native shale mud from the Premont field, Jim Wells County, Texas.

Addition of large quantities of bentonite and water, amounting almost to a replacement of the native mud, and heavy chemical treatment provide a satisfactory mud while drilling the shale in which the calcium sulphate occurs. A less expensive practice is to add a few sacks of Anhydrox daily while drilling the section. For the example shown in Table 6, 2 lb per bbl was adequate. The amount of Anhydrox needed in drilling about 1000 ft of the shale section ranges from 2000 to 3000 lb.

TABLE 6. Treatment of anhydrite mud with Anhydrox mud from Premont field, Texas.

Anhydrox added, lb/bbl	0	1	2
Weight, lb/gal	9.9	9.9	9.9
Viscosity, cp	18	10	12
Initial gel, g	27	20	5
10-min. gel, g	27	35	25
pH	7.8	8.7	9.1
Water loss, API, cc	42.8	27.2	18.4
Cake, 32nd of an in.	7	5	4
Analysis of filtrate:			
Calcium, epm	13		0.2
Sulphate, epm	45		0.6

● **Control of anhydrite by organic colloid.** The use of organic colloids, particularly modified starch, to overcome the deleterious effects of soluble salts has been discussed in detail in a preceding paper* and the general features of such treatment will not be reviewed at this time.

Impermex† came into use in the Tri-States area late in 1944 and was responsible for the second marked decrease in average water loss shown in Fig. 1. By using Impermex to maintain a mud of low water loss, contamination by anhydrite is ignored rather than combatted.

The method commonly used in this area to prevent fermentation of Impermex is to maintain the pH between 11.5 and 12.0. Caustic soda and quebracho, and, in some cases, soda ash and lime are added to the mud until the pH is raised to about 12. Impermex is then added to reduce the water loss to the desired value, usually less than 3 cc.

An example of the conversion of an anhydrite-contaminated mud to a high-pH-Impermex mud is shown in Table 7. In raising the pH, soda ash and caustic soda were used, quebracho being employed to control the viscosity. The water loss dropped from 55 cc to 5.8 cc on adding 5 lb of Impermex per bbl of mud, and was further reduced to 2.4 cc after 10 lb per bbl had been added.

TABLE 7. Treatment of anhydrite mud* with Impermex.

Soda ash added, lb/bbl	0	1.0	1.0
Caustic soda added, lb/bbl	0	1.5	1.8
Quebracho added, lb/bbl	0	1.0	1.3
Impermex added, lb/bbl	0	5.0	10.0
Weight, lb/gal	9.9	9.9	9.9
Viscosity, cp	17	12	21
Initial gel, g	25	0	2
10-min. gel, g	25	20	30
pH	7.3	11.8	11.8
Water loss, API, cc	55.0	5.8	2.4
Cake, 32nd of an in.	7	2	1
Analysis of filtrate:			
Calcium, epm	36		
Sulphate, epm	60		

*Mud from Marion County, Texas, containing 10-lb/bbl anhydrite.

As with the Anhydrox treatment, the preferred method is to keep the mud in good condition at all times by changing to an Impermex mud before the anhydrite is drilled. Usually about 5 lb of mud is ample for the initial treatment. About 250 lb per tour are added for maintenance, along with about 150 lb each of caustic soda and quebracho.

● **Benefits derived from improved mud control in drilling anhydrite.** In conclusion, some of the benefits derived from the use of Anhydrox and Impermex in overcoming the injurious effects of anhydrite on mud will be illustrated by field examples.

1. *Saving time on fishing jobs.* Formerly it was accepted that whenever pipe was lost in the hole as a result of a twistoff, it was necessary to wash over and cut the pipe in lengths not exceeding 600 ft. Because of the shortage of steel, it has been necessary for operators to continue to use drill pipe that would have been discarded in normal times. The successful control of mud properties has effected a saving in time spent in fishing for drill pipe, which far outweighs the cost of the mud materials used.

Typical of the many examples that could be cited are the following: In the Dorcheat field, Columbia County, Arkansas, with the Cotton Valley series exposed, pipe was recovered twice with an overshot from below 7500 ft. On another well in the same field, 2500 ft of pipe was recovered with an overshot, from a depth of 8500 ft after having remained on bottom 16 hr. In a well in the West Atlanta field, Columbia County, Arkansas, pipe was recovered four times at depths greater than 7500 ft. On a well in the Haynesville field, Claiborne Parish, Louisiana, pipe was recovered with an overshot after being on bottom 90 hr.

2. *Saving on casing.* Scarcity of steel during the war placed the emphasis on saving of the material rather than the cost, yet the cost factor alone is more than enough to justify careful attention to the maintenance of a good drilling mud. In the Haynesville field, Claiborne Parish, Louisiana, improved mud control has made it practical to set only 3500 ft of pipe as against 5400 ft formerly required. In the Benton field, Bossier Parish, Louisiana, an old hole, originally drilled to 5600 ft, having 600 ft of surface pipe, was cleaned out and deepened to 9200 ft without setting additional casing. In another field, operators found that by careful mud control, the amount of surface casing could be reduced to 1000 ft instead of using 2500 to 3000 ft.

3. *Saving on time required to drill a well.* The overall time required to drill a well has been reduced as a result of improved mud control. By avoiding the troubles brought on by high-water-loss muds, the time wasted in rectifying these difficulties is saved. Hazards of sloughing, caving shales, and thick filter cake on porous formations have been minimized, thereby eliminating many fishing jobs. Time spent in treating mud has been greatly reduced because the mud is never allowed to become unsatisfactory.

4. *More reliable information for completion.* By maintaining a mud of low water loss, the operator is able to obtain more reliable information on the fluid content of the formations drilled. Cores show less flushing, cuttings are more representative, and electrical logs are improved, particularly with regard to interpretation of the resistivity log. Better results on drillstem tests are obtained because of less flushing of the original fluid content.

● **Acknowledgment.** Grateful acknowledgment is made of the assistance of H. E. Mallory, who supplied the field results cited in this paper. ★ ★ ★

*"Use of Organic Colloids in Drilling Muds," *Geo. R. Gray.*

†U. S. Patent 1,991,637 P. E. Harth Assignor to National Lead Company. "Impermex" is the trade name for the organic colloid marketed by Baroid Sales Division, National Lead Company.

Shell plans Venezuela development

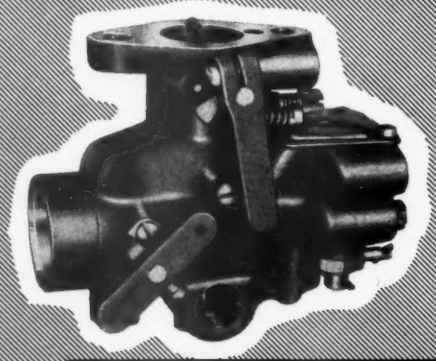
Walter Leslie, general manager of Shell interests in Venezuela, announced the company was ready to invest $100,000,000 to intensify oil production in that country. Several additional millions will be invested for agricultural development, in agreement with Venezuelan Development Corporation and Rockefeller Corporation, Leslie said.

He added that his company was not afraid of the competition of Near East oil and that heavy capital investments by it and other foreign oil companies in Venezuela showed their confidence in the future.

ENSIGN

CARBURETION

Ensign Model "F" Fuel Regulator widely used on engines up to 25 H.P.

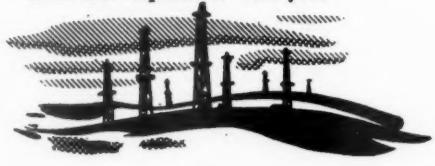


Ensign Model ¾ "Tg" Combination Gas and Gasoline Carburetor.

Ensign Fuel Regulators and Gas Carburetors function together to make a highly efficient and controlled mixture of air and fuel necessary for correct combustion under all operating conditions.

Ensign Carburetors and Fuel Regulators for Natural Gas and Butane-Propane are made for internal combustion engines of all types and sizes, from the constant speed stationary engine to high speed power units.

The design and production of dependable carburetion receives our undivided attention. We have specialized in the field of industrial carburetion for over 35 years and shall be pleased to share our experience with you.



This International Harvester model "U4" Power Unit is equipped with Ensign model "F" Fuel Regulator and model ¾ "Tg" Combination gasoline and natural gas Carburetor.

ENSIGN CARBURETOR COMPANY

7010 SOUTH ALAMEDA STREET • P.O. BOX 229 • HUNTINGTON PARK, CALIFORNIA

BRANCH FACTORY: 2330 WEST 58th STREET, CHICAGO 36, ILLINOIS

DISTRIBUTORS AND DEALERS IN ALL PRINCIPAL OIL FIELDS.

The determination of stresses in oil well casing in place*

By C. H. OBERG and R. W. MASTERS, Standard Oil Company of California

● **Abstract.** This paper describes the equipment and method used to determine the magnitude of the changes in stress in oil-well casing after it was in place in a well and while it was affected by varying temperatures and pressures during drilling and producing operations. The data from two tests indicate:

1. The casing landing tension varies greatly as the casing is affected by temperature and pressure conditions in the well.
2. The freeze point of the casing sometimes rises very rapidly from the top of the cement to the shoe of the next size casing.
3. Temperature and pressure changes tend to cause the casing above the top of the cement to move up or down through any freeze points that are quickly formed by caving formations.
4. All casing above the top of the cement tends to act as free casing because of the movement of the casing through the caved-in freeze points.
5. Apparent freeze points above the top of the cement may cause erroneous landing weights.
6. Properly landed casing will not develop dynamic stresses of dangerous magnitude during drilling operations carried on inside of it.
7. Stress variations during producing operations are likely to be more severe than those encountered during drilling operations.

● **Introduction.** There has been considerable discussion as to the proper tension with which to land long strings of casing so as to provide a proper margin of safety under great changes of temperature and pressure during later drilling and producing operations. There has been also some question regarding the size of the dynamic stresses induced by drilling operations inside this casing. Most of these discussions have been based on calculations and assumptions that did not have the benefit of complete field data on the stresses encountered in casing after it is cemented in place and landed on the casinghead. It was in an attempt to obtain this field data that this test was conducted.

As several casing failures have occurred in wells at Kettleman Hills, it was decided that the test should be conducted in that field. The normal procedure at Kettleman Hills is to set either 500 ft or 2500 ft of 13⅜-in. surface casing, the greater length depending on whether the well is drilled in a portion of the field where greater trouble with

*Presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Los Angeles, California, May 15 and 16, 1947.

FIG. 1. Gauge and cable location in well.

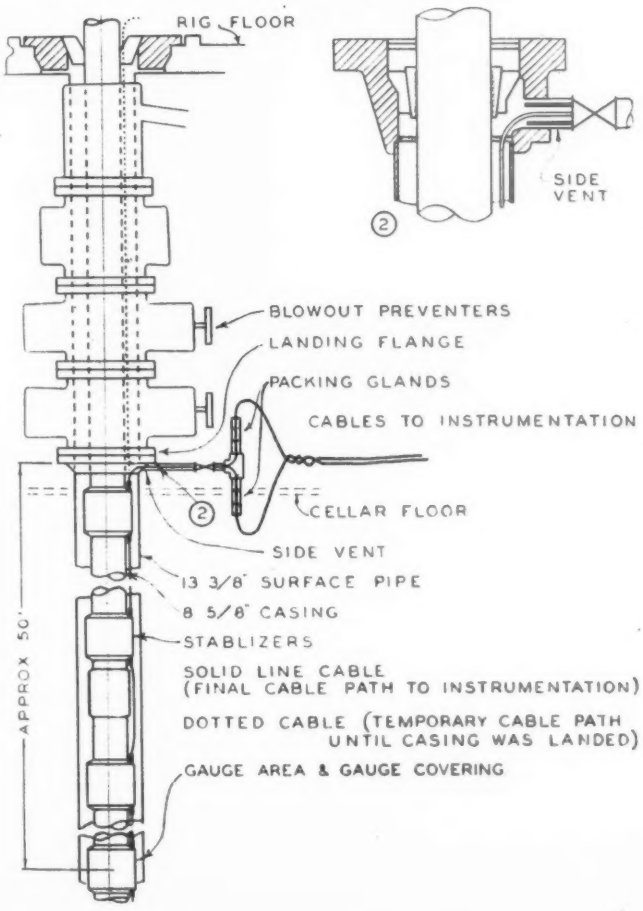
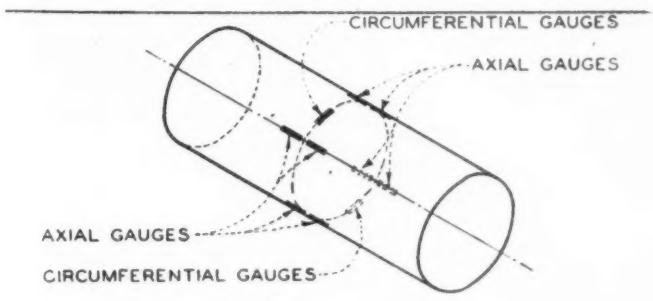
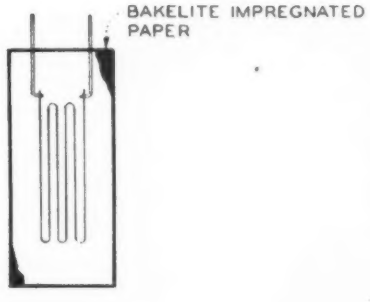


FIG. 2.

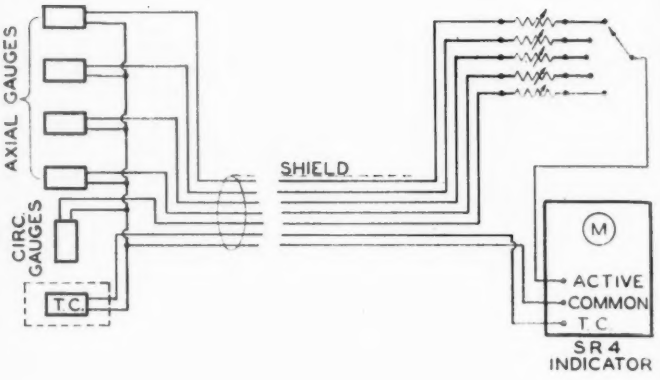


GAUGE LOCATION DETAIL



GAUGE DETAIL

FIG. 3. Installation of gauges on casing.



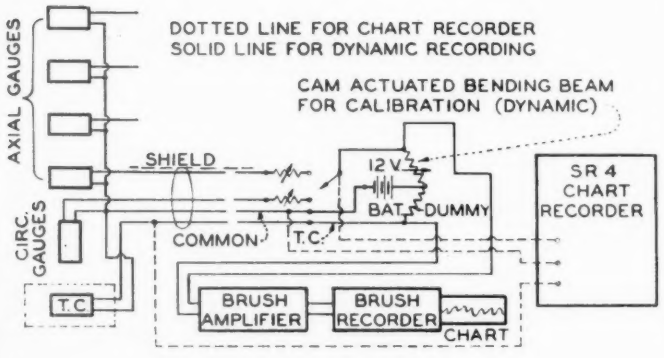


FIG. 5. Electric circuit.

FIG. 4. Installation of gauges on casing.

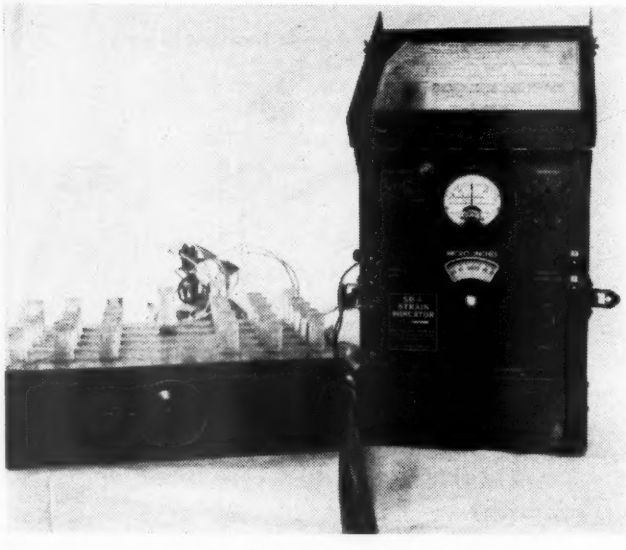


FIG. 6. SR-4 Strain indicator

lost circulation is encountered. Next, approximately 7000 ft of 8⅝-in. casing is set above the pay and cemented with 1000 sacks of cement from 7000 ft to about 4500 ft. Then, approximately 1500 ft of hole is made before setting liner. It was decided to attempt to obtain the stresses in the 8⅝-in. casing as considerable drilling operations are carried on inside of it and because it is used as the production string. It was also decided to check this casing in two wells, well No. 23-11P with 500 ft of surface casing and well 84-21Q with 2500 ft of surface pipe in order to be assured of a great variation in the length of free 8⅝-in. casing.

Strain gages were placed on the two strings of casing approximately 50 ft below the casing landing head. Electric cables were conducted from the gages, through the landing head to the stress recording instruments on the surface. The general set-up of the equipment is shown in Fig. 1.

● **Description of equipment and installation. Strain gages.** Because of the limited space available, because of temperature and moisture conditions encountered, and because of the need for remote reading, the gage chosen for use in this test was the Baldwin-Southwark SR-4, Type AB-3, resistance wire strain gage. (Fig. 2.) This type of gage consists of a 1-mill diameter advance wire grid of 120 ohms resistance laid out on a very thin, raw bakelite impregnated paper. When this gage is cemented to a piece of material under test, its resistance varies as it changes in length with the stressed material. A measurement of this change in resistance, when properly

It's Here!

the new BS & B STEP THROTTLING OIL VALVE

• Designed by Black, Sivalls & Bryson for operations where close separator level control and smooth, steady action are essential. The B S & B Step Throttling Oil Valve is a diaphragm operated valve, controlled by a rotary master pilot valve, which throttles by "steps." An increase or decrease in well flow directly actuates the pilot valve lever arm which transfers the differential gas operating pressure to the oil valve by opening or closing a system of eight supply and exhaust ports in the pilot valve. The jump from one step to another is small. Steady "step" action stops fluctuations in oil flow from the separator... prevents pressure fluctuations in the gas discharge line... stops "hunting"... makes possible a maximum variation in separator oil level of only ¼ inch. The result... clear orifice meter chart readings, fewer metering and heating problems in the oil flow line.

WRITE FOR NEW BOOKLET!

Send for the complete information . . . details, description, specifications . . . of the B S & B Step Throttling Oil Valve. Address: Oil Field Equipment Division, Executive Offices, Black, Sivalls & Bryson, Inc., Power and Light Building, Kansas City 6, Missouri.

FOREIGN INQUIRIES INVITED

EFFICIENCY

Cable Address: BLACK, KANSAS CITY, U.S.A.

BLACK, SIVALLS & BRYSON, INC.

RELIABILITY

KANSAS CITY, MO.
CASPER, WYO.
OKLAHOMA CITY, OKLA.
CALGARY, ALTA.

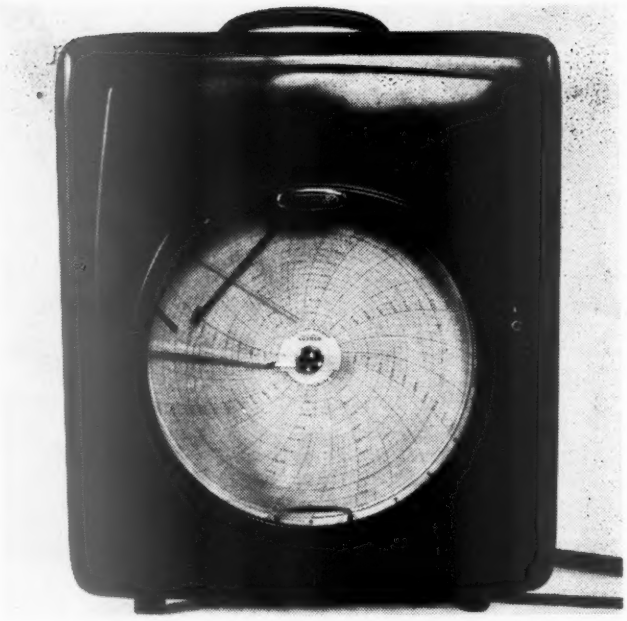


FIG. 7. SR-4 Strain recorder.

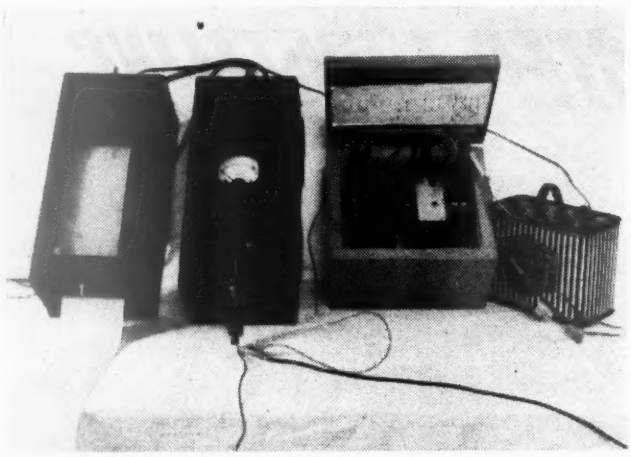


FIG. 8. Brush oscillograph equipment.

FIG. 9. (Left) Gauge section going in hole.

FIG. 10. Freeze point vs time 23 11-P.

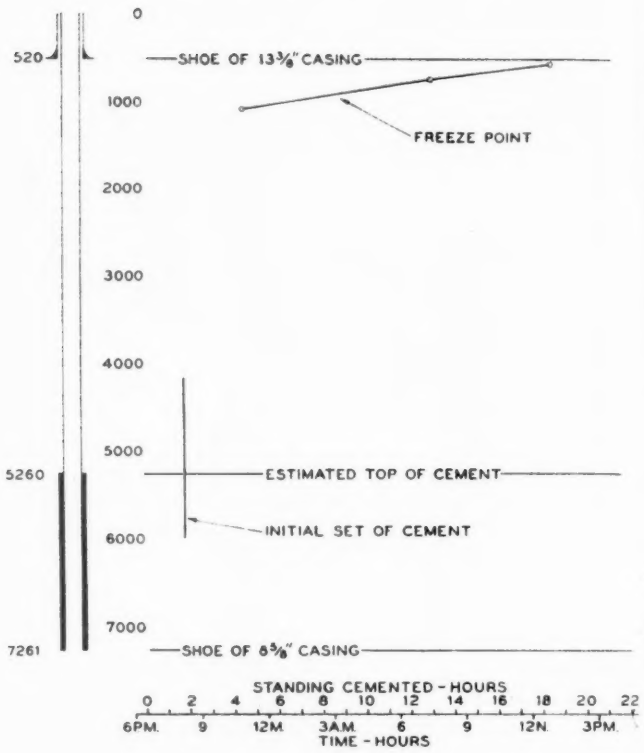
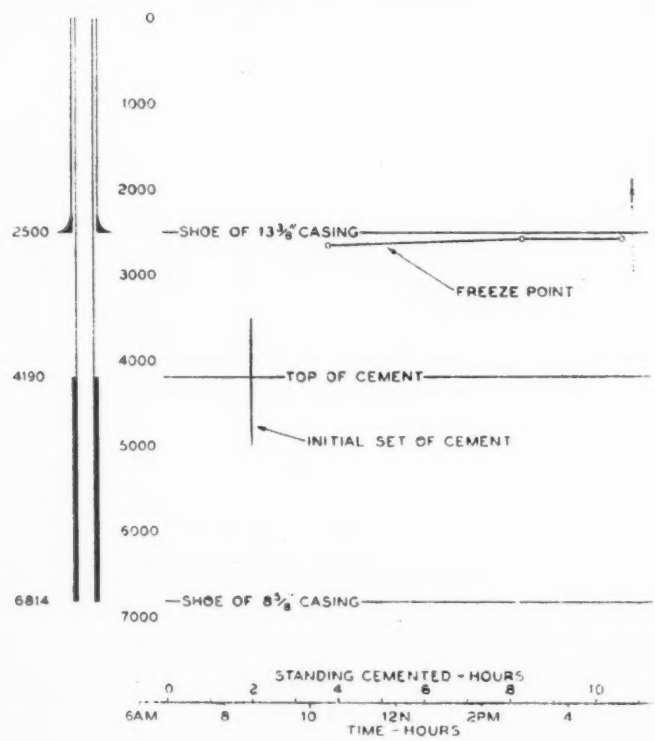


FIG. 11. Freeze point vs time 84 21-Q.



EVEN AFTER 3¼-HOUR SHUT-DOWN . . .

Unaflo pumps easily —sets hard

Job No. OW-U-20
Louisiana Coastal Area

UNAFLO FILE FACTS:

Temperature: over 200° F.
Pressure: 4,400 PSI bottom-hole
Depth at Squeeze: 9,000 ft.

Squeezed to 5,000-lb. pump pressure when 235 sacks of Unaflo remained in tubing. When reversing started, blow-out preventer cut out. 3¼ hours elapsed until another pack-off was installed. "Unaflo then reversed out as easy as it went in," the operator said.

Unaflo, the cement with the delayed, postponed, *retarded* set, provides excellent protection for the oil-well investment. It remains fluid and pumpable for the entire period of retardation—even with heavy slurries under high temperatures, pressures, and unforeseen delays. Then it sets to a hard, impermeable seal.

Send for further information.

PE-U-79

Waco; Kansas City; Birmingham; Chicago; New York
Export Distributors: United States Steel Export Company, New York

UNIVERSAL ATLAS CEMENT COMPANY

OIL-FIELD CEMENTS

Unaflo *Retarded* Oil-Well Cement
Resistant to Sulfate Waters
Atlas Portland Cement—Type I
Atlas Portland Cement—Type II
Resistant to Sulfate Waters
Atlas High-Early Cement—Type III

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—ABC Network*

converted, indicates the change in stress in the material.

To provide assurance that some of the gages would always operate properly, there was duplication in the application of the gages and great care was taken in the shop installation of the gages to obtain a proper bond to the pipe and to obtain a moisture-proof covering over the gage area. Two sets of gages, consisting of six gages per set, were used on each of the two test joints of 8⅝-in. J-55, LIU, 32-lb casing. (Fig. 2.) Each set of gages was composed of four gages cemented axially to the pipe at 90 deg. spacing around it, one gage cemented circumferentially to the pipe, and a temperature compensator gage cemented to a small slug of steel so mounted in the gage area as never to be stressed. The temperature compensator gage for each set was common to the other five gages.

The gages were cemented to the casing with bakelite on a sand-blasted and filed area approximately 10 ft from the mill end coupling. The gage leads were brought out to a micarta terminal strip and the entire area was wound with glass string to hold the wiring and compensators in place. (Figs. 3 and 4.)

Each joint was equipped with two 200-ft, seven-conductor shielded cables. The ends of these cables were fanned, bonded with rubber, and the cable ends soldered to the Micarta terminal strip. A neoprene covering was vulcanized over the entire area and around the fantail cable ends. Over this neoprene was stretched a rubber drill pipe stabilizer as protection against mechanical shock and abuse. This section was tested for leakage by immersing in water for 60 hr.

● **Instrumentation.** A Baldwin-Southwark Type SR-4 Strain Indicator (Fig. 6) was used to take static strain readings on one set of the two complete sets of gages in each well. As shown in the electrical circuit in Fig. 5, the temperature compensator leg and the common leg of the gage set were hooked up permanently to the indicator terminal. The active gage legs were connected through a selector switch and balancing resistors. This enabled the operator to take static readings on all five gages very rapidly.

The spare set of gages was used for static and dynamic recording. Static recording was accomplished by using an axially located gage with the spare temperature compensator feeding into a Baldwin-Southwark SR-4 Chart Recorder. (Fig. 7.) This instrument recorded for 24-hr periods and gave a continuous record of the stresses in one gage.

The dynamic instrumentation consisted of an axially located gage with a temperature compensator gage in a bridge circuit with two dummy gages placed at the instrumentation location. One of the dummy gages was bonded to an electric motor-driven, cam-actuated, bending beam for calibration. The change in strain produced in the bending beam for one complete revolution of the cam was accurately measured; consequently, by turning on the electric motor drive at any time during the test, a dynamic signal of the desired frequency and known amplitude was injected into the dynamic recording equipment for calibration purpose. The dynamic bridge was powered by a 12-volt d-c source and the bridge output fed into a Brush Amplifier, and, in turn, to a Brush Crystal direct inking oscillograph. (Fig. 8.)

● **Loading calibration.** The loading calibration was attained by suspending the test joints of casing in a derrick, anchoring one end to a well substructure, and the other to a hook. Loading was accomplished by means of a hydraulic cylinder pulling on the dead line. By knowing the area of the piston in the hydraulic cylinder, the applied pressure, and the block ratio, the applied loads were calculated by the formula:

$$L = P \times A \times K$$

Where:
L = applied tension load, psi
P = gage pressure, psi
A = piston area, sq in.
K = block ratio.

By taking strain gage readings at various increments of load, calibration charts of strain in micro-inches vs. stress in thousand pounds per square inch could be made. These charts were used during the test to convert strain gage readings in micro-inches to lb per sq in. stress.

● **Pressure calibration.** The test joints were calibrated for gage sensitivity to internal pressure by capping the ends of the casing and then applying hydraulic pressure. Strain readings were taken on all gages at 400 psi pressure increments up to 2000 psi. As indicated above, these data were obtained with ends of the test joint capped and with the ends free to move; however, the casing in the well was open on each end and the ends were more or less fixed. Hence, the above calibration data had to be used in conjunction with the loading calibration data to obtain representative strain vs. pressure calibration charts.

● **Placing equipment in well.** It was deemed advisable to keep the gage location after landing the casing within limits of 10 ft to 60 ft below the casing-head and it was decided to run the test joint as the next to the last joint in the casing string. To avoid delay in running the casing, the test joint and the top joint of casing were made up together and stood back in the derrick a day or two prior to the time of running the full string of casing. At this time, the electric cables were conducted from the gages through holders placed at 5-ft intervals on the top joint. These holders consisted of two ½-in. by 12-in. pipe nipples held in place by rubber drill pipe stabilizers. The cables were threaded through these nipples and were held closely to the casing, which prevented the cables from being damaged as the casing was lowered into the hole. The casing string was run as usual, except that the two top joints were picked up as a unit. Fig. 9 shows the gage area of

How to SPEED Drill-Pipe Inspection!

PREPARE tool joints for magnetic inspection with Oakite Steam-Detergent Cleaning! Delivers right to the trouble-spot a combination of controlled heat, powerful impact and vigorous Oakite detergency. Makes drill-pipe checking easier . . . faster . . . more certain. Offers a quick way to uncover hidden pipe failures and avert costly field breakdowns.

Other Money-Saving Uses!

You can employ the Oakite Steam-Detergent Cleaning technique in many other jobs where fast removal of grease, oil and sand deposits is called for. The Oakite Technical Service Representative nearby will show you where and how this money-saving, scientific method works to best advantage. Arrange TODAY for his free help.

FREE! Drop a line NOW for your free copy of the 28-page Oakite guide to improved petroleum maintenance, a manual of 88 job procedures worked out on the proved Oakite cost-saving plan.

OAKITE PRODUCTS, INC.
48 Thames Street, NEW YORK 6, N. Y.
Technical Representatives in Principal Cities of U. S. & Canada

OAKITE
Specialized Industrial Cleaning
MATERIALS • METHODS • SERVICE

the casing as it was about to be lowered into the well bore.

As soon as the casing was in the hole, and while circulation prior to cementing was in progress, the cables were passed over the top of the blowout preventers, connected to the recording instruments, and readings taken. After temperature surveys were taken to locate the top of the cement, and, after the cement had set, the cables were disconnected from the instruments, fished out through the valve opening in the casinghead, passed through stuffingboxes on the head, and reconnected to the instruments. At this time the casing was slacked off until there was no tension on the top joint and the strain gages were rechecked for "zero" readings. Finally, the casing was landed on the slips of the casinghead at a predetermined landing tension and the strain readings recommenced.

● **Initial landing tension.** The casing in each test well was landed approximately in accordance with the method described by John P. DeHetre[1]. In using this method, the most important consideration is the freeze point, which is the shallowest point at which the casing is held fast by the cement or the formation that has sloughed in.

The first freeze point determinations were made about four hours after the cement was in place. The freeze point was determined by slacking off weight in increments of 10,000 lb and measuring the amount the casing settled for each increment. The freeze point was then determined by plotting the data and applying the slope of the curve to the stretch formula. This was found to be the most accurate method for this determination when using a weight indicator. It was believed that the freeze point would be located initially at the top of the cement and would move gradually up the hole to the shoe of the next size casing as the formation sloughed in around the casing. In the two wells of this test, however, the formation caved in quickly and the freeze point rapidly moved to the vicinity of the shoe of the surface casing; namely, to 578 ft in Well 23-11P and to 2570 ft in Well 84-21Q. (Figs. 10 and 11.)

In landing the casing at both wells, the prime consideration was to put enough tension in the pipe so that no casing above the freeze point would be in compression under a condition of increased temperature. Well conditions that tend to increase the tension had to be investigated to see that the safe limits of the pipe would not be exceeded. In Table 1 are the calculations for both wells, assuming an average temperature rise of 50 F, a drop of 40 F, and a pressure increase of 2000 psi.

It is to be noted that the estimated maximum landing tension at both wells was below the allowable tension. At 23-11P the casing was landed with about 25,000 lb more tension than the calculated minimum landing tension. It was felt that the calculated desirable tension was too low, and by increasing the landing tension slightly it would still be well within the allowable limits even with the anticipated increases in tension. At 84-21Q the casing was pulled up above the desired landing tension to allow for settling of the landing slips. The slips, however, did not settle as much as anticipated and the casing was landed with about 10,000 lb more tension than desired.

In landing casing it has been the practice to refer the landing tension to the tension with the pipe in the cementing position. The above table shows the tension slacked off at 23-11P and picked up at 84-21Q from the cementing position as well as the distance the casing was moved.

Before landing the casing it was necessary to balance the resistances in the electrical bridge circuit with no tension on the pipe, so that the instruments would indicate the actual tension. At 23-11P this was done by slacking off all the weight and adjusting the variable resistances. This operation required only 6 to 8 min, and on picking up the casing it returned to the same position at the same tension. However, at 84-21Q it was necessary to slack off all the weight for a period of 45 min while resistance wire was cut and soldered to provide fixed resistances. At the end of this interval the casing was picked up again to its original tension and was found to be

FOR THE BEST IN CABLE TOOLS

SPANG
FULL CIRCLE SLIP SOCKETS
(Fig. F482)
and
COMBINATION SOCKETS
(Fig. F497)

Spang Slip and Combination Sockets are rugged and tough. Room in the hole to add mass is limited, so Spang has substituted steel quality and heat treatment to give that extra strength needed to stand long heavy jarring when it is necessary.

They are carefully forged, thoroughly heat treated, and accurately machined. You can count on them!

Even a soft, simple fishing job can get tough and complicated. That's why it pays to always use only the best fishing tools for any fishing job. For the best in Cable Tools, SPECIFY SPANG.

THE HIGHER STANDARD

SPANG & CO.
BUTLER, PA.

YOUR DEALER SELLS SPANG TOOLS

..the EXTRA advantages
..the GREATER compactness
..the WIDER selection

you get with

SHAFFER SPOOL TYPE LANDING HEADS

Shaffer Full Opening Spool Type Landing Head Assembly

Shaffer—the *pioneer* of this type of landing equipment—still provides the most advanced, the most adaptable, and the safest equipment you can use for landing and packing-off each individual string of casing in your well. Shaffer Spool Type Landing Heads have not only been used for landing the longest and heaviest strings of casing, but they also have been used on wells where highest pressures have been encountered—your assurance that this equipment has been thoroughly tested and field-proven for *all* modern drilling and completion requirements.

Shaffer Landing Heads are available to meet all API pressure ratings...API Series 400, 600, 900, 1500 and 2500...a complete range for every pressure requirement. And *all* Shaffer Heads offer the following unique advantages...

1. Each individual string is landed with complete safety at any desired point without necessity of "letting go," measuring or re-threading.
2. Each string can be landed with a pre-determined amount of stretch, thus supporting the string so that it cannot become damaged through buckling or sagging.
3. Each string is supported on its own flange with an upper flange provided for the support of the next string.
4. Each string is suspended on its own set of slips and no accumulated weight is placed on those slips by succeeding strings of casing or tubing. All weight is transferred directly to the base.
5. Each string is packed-off securely against high pressures with provisions for gas outlet, mud line or overflow connections incorporated directly into the Spool units.

INSTALLATION IS SIMPLE, POSITIVE: Note how simple and safe it is to land a string of casing with Shaffer Heads. With the casing suspended from the elevator or spider, you simply take the desired amount of stretch in the string and set the slips in the Head, thus transferring all weight to the Base unit. Then, with a torch, the casing is cut off flush with the top of the Head, the packing unit inserted—and the job is done. No welding (with its many uncertainties) is required. It is never necessary to unscrew or "let go" of the string to complete the landing operation. Nor is it necessary to cut casing nipples to proper length for connecting the casing to the Landing Head.

WIDE CHOICE OF PACKING UNITS

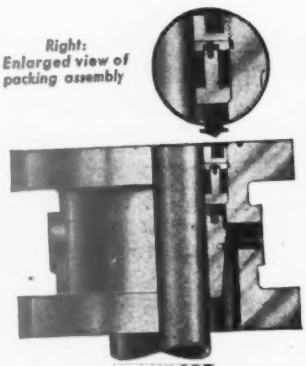
Five different types of packing units are available for packing off between casing and Shaffer Full Opening Heads—the four described below, plus an all-metal Model D Full Opening Packing Unit (not shown) which is similar to the packing unit of the Model D Base Head shown on opposite page.

ADVANTAGES OF FULL OPENING DESIGN

In the Shaffer Full Opening design the head above the last string of landed casing has an opening to the full internal diameter of the casing being drilled through. Therefore, it passes bits, reamers and any other tools that will pass through the casing, permitting several time-saving, labor-saving advantages...

- The drilling connection can be made to a fixed length with the head in place and need not be shortened to allow for a head when the casing string is to be run.
- With the complete casing program known in advance, a multiple stack of Full Opening Heads may be installed and the drilling connection need never be changed throughout the drilling of the well.
- Any desired changes in the casing program can be made by simply changing the size of slips and packing unit, thus permitting maximum adaptability to unforeseen development requirements.

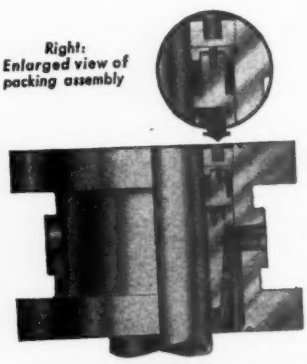
Right: Enlarged view of packing assembly



STANDARD
Full Opening Packing Unit

Has two separate rubber packing rings—one sealing around the casing, the other against the head, and both compressed simultaneously by tightening a single ring nut. Both the packing unit and slips seat directly in the bore of the head.

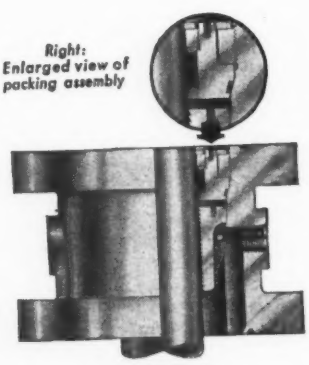
Right: Enlarged view of packing assembly



MODEL A
Full Opening Packing Unit

Is similar to the Standard unit described at left except the packing unit seats on a slip spider which is supported on a shoulder in the internal bore of the head. The tapered slip spider also supports the slips in the head.

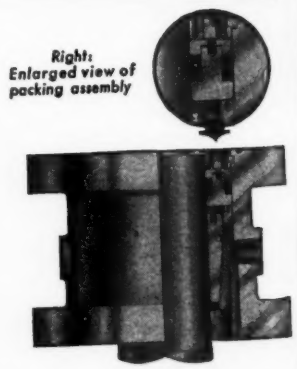
Right: Enlarged view of packing assembly



MODEL B
Full Opening Packing Unit

Has a rubber packing ring around the casing and a composition packing ring seating against a tapered shoulder in the bore of the head. Each packing element is packed off separately by individual ring nuts and the slips seat directly in the tapered bore of the head.

Right: Enlarged view of packing assembly



MODEL E
Full Opening Packing Unit

Requires no threads in the internal bore of the head to tighten the packing unit. Separate rubber packing rings seal around the casing and in the bore of the head and are tightened by set screws. A compressing locking ring which is held in place by a snap ring inserted in a groove in the body.

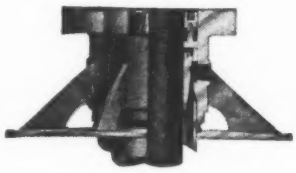
For maximum compactness...

SHAFFER COMBINATION LANDING BASE HEADS

Where cellar space is at a premium, the Shaffer Combination Landing Base Head is ideal. It provides in *one* unit a Base and Head having a total vertical height equal to or less than the height of a conventional head *alone*. The Shaffer Base Head is attached to the surface casing in the same manner as a regular landing base—usually welded, but can be furnished with screw connections if preferred. The top portion of the Head is so designed that the next string of casing can be landed and packed-off in this portion of the Base Head in the same manner as in a separate Landing Head.

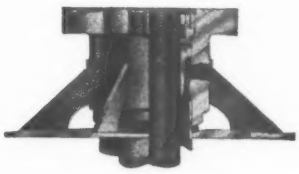
FIVE TYPES

Shaffer Combination Landing Base Heads are available in *five* types to meet various requirements. In addition to the four types shown below, a Shaffer Model E Combination Landing Base Head is also available in which the packing unit and snap ring construction are essentially the same as the Model E Full Opening Packing unit shown on the previous page.



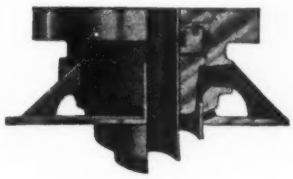
MODEL A

Has two separate rubber packing rings packed off simultaneously by tightening a single threaded ring nut. Slips seat in a split spider supported on a shoulder in the bore of the Base Head.



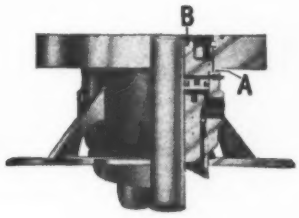
MODEL B

Has a rubber packing ring around the casing and a composition packing ring seating against a tapered shoulder in the bore of the Base Head, each packed off separately by threaded ring nuts. Slips seat directly in tapered bore of body.



MODEL C

Is similar in design to Model A except vertical dimensions of the various parts have been reduced to provide even greater compactness. Slip area, though reduced, is ample to carry the casing weight.



MODEL D

Has an all-metal packing unit and no internal threads are used for holding the packing unit in place. It does not depend upon the head above to effect its seal. Internal bore of the Base Head is sealed by copper ring (A)...casing by full-circumferential weld (B). Snap ring in groove holds packing unit in place.

SHAFFER LANDING BASES

Shaffer Landing Bases—thoroughly proven and dependable for all requirements—are available in *two* basic types...the Shaffer Regular Landing Base and the Shaffer Split Landing Base.

The Shaffer Regular Landing Base is available in both flange and flangeless types. The flange type is usually welded to the surface casing but can be furnished with screw connections if preferred. With this Base, the Landing Head is flanged and bolted to the Base. The upper flange of the Base carries slots for the tie-down rods and is regularly furnished to meet API ring joint specifications, but can be supplied on order, to fit any head. With the flangeless type, the surface string is first welded to the Base, after which the Landing Head is welded to both the Base and the casing string. Slots for the tie-down rods are located on the perimeter of the Landing Head flange.

Shaffer Regular Landing Base—Flange Type with secondary welding slots and test weld features

UNIQUE TEST-WELD FEATURE

Shaffer Regular Landing Bases are furnished with Secondary Welding Slots (A) and can be furnished with Test Weld Features in which a molded packing ring is inserted into the groove cut in the bore. Prior to test, plastic packing is injected behind this ring, effecting a seal around the pipe. A pump is then connected to a threaded opening between the weld and packing ring and hydraulic pressure can be applied to test the weld.

SHAFFER SPLIT LANDING BASES

Can be placed without "letting go" of the surface string and also provide important advantages where space is limited, since the two halves can be brought in separately, clamped around the casing in very close quarters, then welded to form a pressure-tight seal.

The above are just a few highlights of the many advanced Shaffer units available for simplifying and speeding modern casing suspension programs. The Shaffer line of completion equipment includes not only the Bases and Heads outlined above, but also a complete line of Tubing Heads, Production Hook-ups and Christmas Trees, a wide choice of Adjustable Flow Beans for production control and many other items. See pages 3454 to 3506 of your 1947 Composite Catalog for further details.

Write for the complete new Shaffer catalog!

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
CASPER, WYOMING, Mountain Sales and Service, 133 North Wolcott Street
EXPORT SALES OFFICE: Shaffer Tool Works, 30 Rockefeller Plaza, New York, N. Y., U. S. A.

TABLE 1

	23-11P	84-21Q
(a) Assumed freeze point	578 ft	2,570 ft
(b) Weight of free pipe to freeze point (32 lb × freeze point)	18,500 lb	82,200 lb
Tension decrease due to 50 F temperature rise (58.2 × W × Δ T)	93,100 lb	93,100 lb
Minimum landing tension (based on assumed freeze point)	111,600 lb	175,300 lb
(c) Tension in casing in "as cemented" position	210,900 lb	156,000 lb
(d) Slack-off from cementing position	74,900 lb	
feet	0.156 ft	
(e) Pick-up from cementing position		30,000 lb
feet (minus 2 in. that casing slid)		0.111 ft
(f) Actual landing tension	136,000 lb	186,000 lb
(g) Tension increase due to 40 F temperature drop (58.2 × W × Δ T)	74,500 lb	74,500 lb
Tension increase due to 2000 psi pressure increase (0.0434 × W × Δ P × D/t)	68,000 lb	68,000 lb
Estimated maximum landing tension (based on actual landing weight)	278,500 lb	328,500 lb
(h) Allowable tension in top joint (based on current safety factors)	350,000 lb	350,000 lb

TABLE 2

	23-11P	84-21Q
(a) Tension in casing in "as cemented" position	210,900 lb	156,000 lb
(b) Top of cement	5,260 ft	4,190 ft
(c) Slack-off (—) Pick-up (+) feet—net	—0.156 ft	+0.111 ft
(d) Tension change in pipe to top of cement $P=\frac{e_s \times W \times 8{,}675{,}000}{L}$	—8,600 lb	+7,600 lb
(e) Landing tension when free pipe and frozen pipe attain equilibrium at normal temp. (a) ± (d)	202,300 lb	163,600 lb
(f) Weight of pipe to top of cement	175,000 lb	138,500 lb

about 2 in. lower than it had been before the tension was slacked off. This lowering of the casing can be explained only by the fact that the casing slid down the hole past the freeze point. It cannot be explained by any buckling of the free pipe while in compression, because the stress due to compression, plus the stress due to bending alone, was well within the strength of the pipe. There are two reasons why the casing slid at 84-21Q, while no perceptible slip occurred at 23-11P: (1) The tension was slacked off considerably longer at 84-21Q, allowing more time for slip to take place; (2) at 84-21Q, neglecting the forces acting below the freeze point, about five times as much casing was in compression above the freeze point as at 23-11P, resulting in a force five times greater, causing slip past the freeze point. A possible third reason is that the formation at 84-21Q did not hold the pipe as tightly as the surface formations did at 23-11P. Slacking off all the tension on the casing in a dangerous practice, and it was done only for the reason given above. In normal practice casing is not moved from the cementing position except to land the casing.

● **Tension changes during drilling operations.** The landing tension at 23-11P immediately after landing the casing is shown in Fig. 12. It is to be noted that the tension rose rapidly during the first 24 hr and then gradually leveled off at a value of 214,000 lb (or 203,000 lb corrected for a temperature of 100 F), which was considerably higher than the initial landing tension. Before the casing was landed, a temperature survey indicated an average temperature of 100 F in the top 500 ft. Forty-eight hours after the casing was landed the cement was drilled out and the tension dropped abruptly to a value almost as low as the initial landing tension. The overflow temperature during this operation was 133 F, and it was assumed that this was the average temperature in the top 500 ft at that time. If it is assumed that the abrupt drop was due to temperature alone, the landing tension referred to an average temperature of 100 F, would be 203,000 lb, or 67,000 lb greater than the initial landing tension.

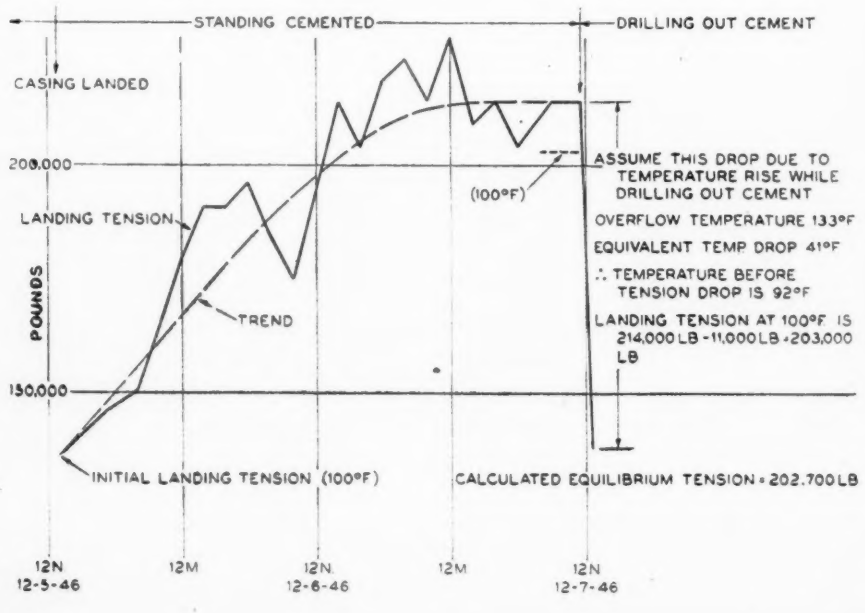
As the effect of temperature was eliminated and as the pressure did not change, the only other factor that could cause this increase in tension was some other force acting to increase the tension in the free pipe. As this force could not be acting at the landing-head, which was fixed, it must have been acting in the frozen pipe and must have been equal in magnitude to the difference between the tension in the free pipe and the tension in the frozen pipe, acting downward when the tension was slacked off as at 23-11P, and acting upward when the tension was picked up as at 84-21Q. To obtain the increase in tension at 23-11P, therefore, it was necessary for the pipe to move through the frozen section above the top of the cement. Thus there was a "slip" through the freeze point that tended to balance the forces acting in the free pipe and the frozen pipe. The casing would still be "frozen," however, as shown by the usual stress-strain relationships, and attempts to recover it below the freeze point by normal methods probably would be futile. As noted above, the casing at 84-21Q slid 2 in. past the freeze point in 45 min and after the cement had been in place more than 10 hr.

Table 2 gives an analysis of the conditions in both wells tending to produce the trends noted.

The analysis is based on the assumption that all the pipe to the top of the cement will act, after an indefinite period, as though it were not frozen from the freeze point to the top of the cement. The tension slacked off or picked up, which initially indicated a freeze point well above the top of the cement, will eventually indicate that the true freeze point is at the top of the cement. Thus at 23-11P the landing tension of 203,000 lb, attained less than 48 hr after landing the casing with an initial tension of 136,000 lb, agrees very well with the estimated equilibrium landing tension of 202,300 lb, which assumes the freeze point at the top of the cement. Note that the landing tension approaches the equilibrium tension at a gradually decreasing rate, and that equilibrium was attained in less than 48 hr.

Only those conditions that existed when the well was standing have been considered so far. The temperature was almost constant at such a time, and the casing tended to attain equilibrium. As the temperature was elevated by circu-

FIG. 12. Landing tension after landing casing 23 11-P.



McKISSICK

TONG BLOCK

with SAFETY Swivel Hook

Light and compact for higher speed, this heavy tong block is equipped with large center pin, full roller bearings and alemite lubrication. It also has the quick opening and safety locking feature.

Catalog on Request

McKISSICK PRODUCTS CORPORATION

BOX 2496

TULSA, OKLAHOMA

FIG. 13. Landing tension during drilling operations 23 11-P.

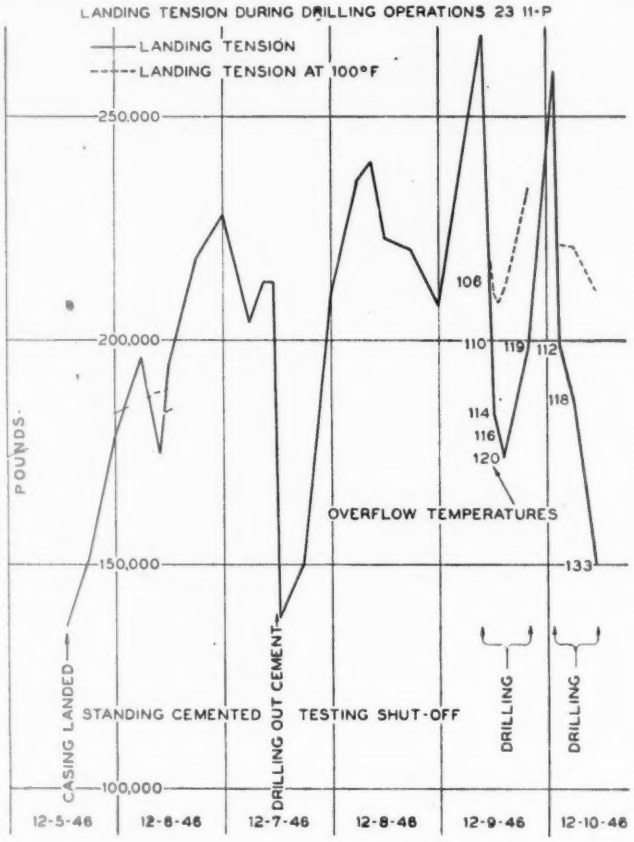
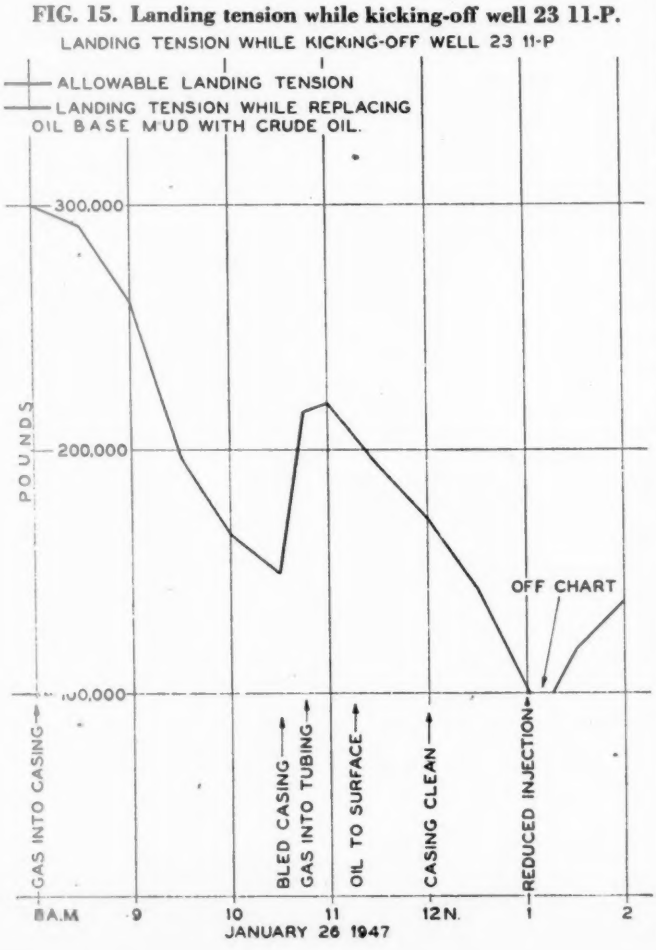
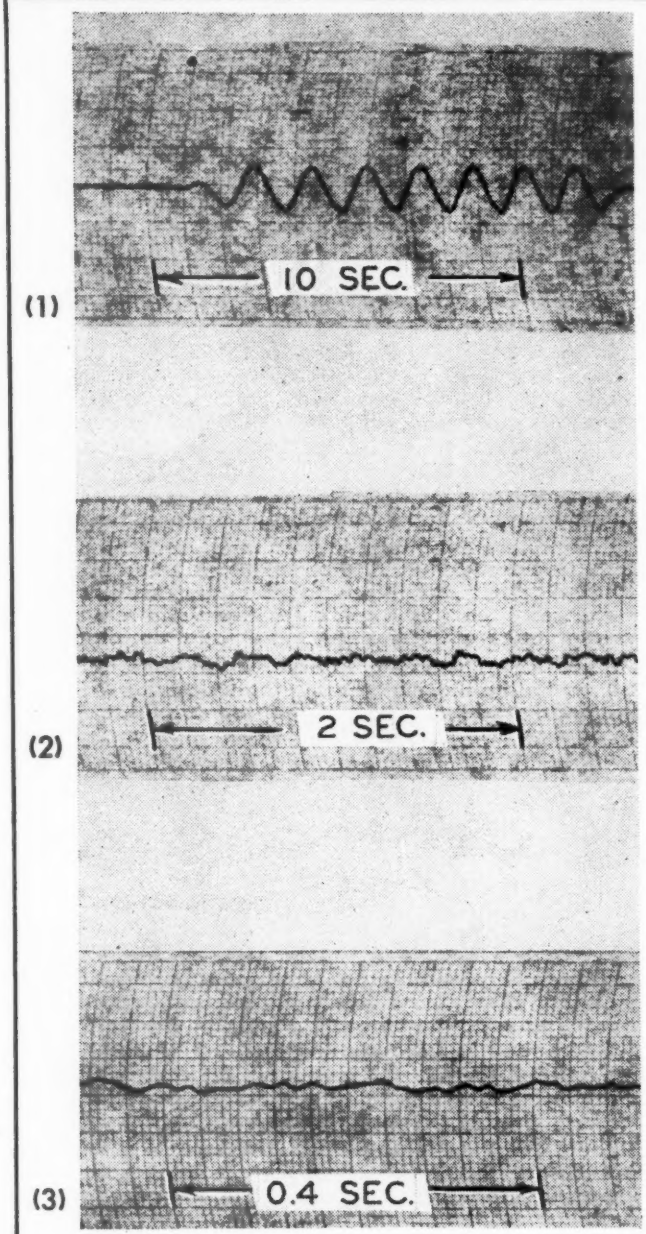


FIG. 15. Landing tension while kicking-off well 23 11-P.





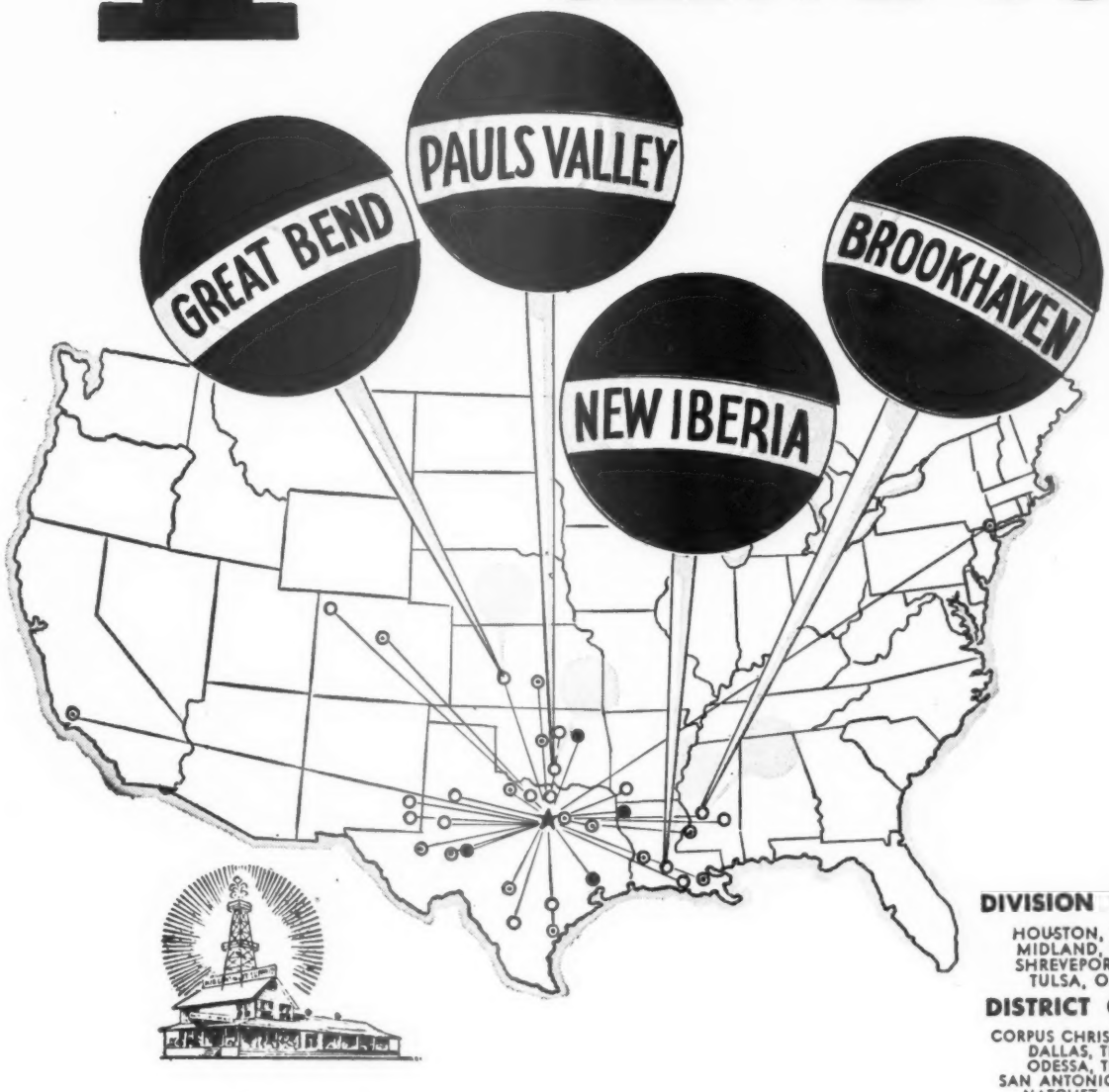
(1) CALIBRATION CURVE
WIDTH OF CURVE = 435 MICRO-INCHES
WIDTH OF CURVE = 13,100 PSI

(2) DYNAMIC STRESS CURVE
WELL 84 21-Q JANUARY 6, 1947
DRILLING AT APPROXIMATELY 8100 FT
KELLY 25 FT UP
ROTARY SPEED 175 RPM. WEIGHT ON BIT 4 TONS
STRESS CHANGE = 165 MICRO-INCHES = 4960 PSI

(3) DYNAMIC STRESS CURVE
WELL 84 21-Q JANUARY 4, 1947
DRILLING AT APPROXIMATELY 7950 FT
KELLY DOWN
ROTARY SPEED 250 RPM. WEIGHT ON BIT 4 TONS
STRESS CHANGE = 109 MICRO-INCHES = 3280 PSI

FIG. 14. Typical dynamic stress curves.

4 NEW STORES TO SERVE YOU!



Here are 4 new
WELL STOCKED
Mid-Continent Stores to supply you

DIVISION OFFICES

HOUSTON, TEXAS
MIDLAND, TEXAS
SHREVEPORT, LA.
TULSA, OKLA.

DISTRICT OFFICES

CORPUS CHRISTI, TEXAS
DALLAS, TEXAS
ODESSA, TEXAS
SAN ANTONIO, TEXAS
NATCHEZ, MISS.
NEW YORK CITY
NEW ORLEANS, LA.
LOS ANGELES, CALIF.
DENVER, COLORADO
WICHITA FALLS, TEXAS
WICHITA, KANSAS
OKLAHOMA CITY
KILGORE, TEXAS
KERMIT, TEXAS

BRANCH STORES

Bowie, Texas
Brookhaven, Miss.
Edmond, Okla.
Eunice, New Mex.
Falfurrias, Texas
Fullerton, Texas (Andrews County)
Gainesville, Texas
Great Bend, Kan.
Hobbs, New Mex.
Houma, La.
Houston, Texas
Kermit, Texas
Kilgore, Texas
Laurel, Miss.
Lake Charles, La.
Magnolia, Ark.
Natchez, Miss.
New Iberia, La.
Odessa, Texas
Okla. City, Okla.
Pauls Valley, Okla.
Refugio, Texas
Rangely, Colo.
Shreveport, La.
Sundown, Texas
Wichita Falls, Texas
Wichita, Kansas

MID-CONTINENT
Supply Company

General Offices Mid-Continent Bldg. FORT WORTH, TEXAS

lating hot mud, the tension in the free pipe decreased and the casing tended to slip farther down the hole. When the drill pipe was pulled the temperature tended to return to normal causing the tension to rise and to pull the pipe back up the hole. Thus during drilling operations the casing appeared to be constantly working up and down the hole through the freeze point due to the repeated changes in temperature.

The landing tension following landing and during drilling operations at 23-11P is shown in Fig. 13. The peaks immediately prior to drilling were due to running cold drill pipe into the hole. The drill pipe standing in the derrick cooled off considerably in the winter weather and each stand as it was run in cooled the mud in the top of the hole. This effect was much more pronounced at 23-11P where the average temperature in the 500 ft of free pipe could be lowered more readily than in the 2500 ft of free pipe at 84-21Q. When circulation was established, after a trip, the tension dropped rapidly as the hot mud from down the hole was circulated out of the casing. In order to analyze the landing tension, it was corrected to 100 F by use of the equation $P = 58.2 \times W$ (lb per ft) $\times$ T (F). This is not strictly correct because the overflow temperature does not exactly indicate the average temperature in the free casing. However, it proved to be a good indicator of the average temperature and gave consistent results. In Fig. 13 the landing tension referred to 100 F shows an initial drop that was probably due to the fact that equilibrium had not been established. Following this the landing tension shows an abrupt rise due to the fact that the tension had been lowered by increasing the temperature and the casing was slipping down the hole. It is to be noted that this rise is at about the same rate as when the well was standing cemented and the tension had reached the same magnitude.

● **Dynamic stress.** Two of the past casing failures at Kettleman Hills occurred in collar threads at depths of less than 200 ft while drilling operations were being carried on inside of the 8⅝-in. casing. Wear on the collar in these failures indicated the casing was slack and that large stress changes were induced in the casing by the rotational hammering of the kelly and drill pipe on the inside of it.

Numerous oscillograph readings were taken in an effort to obtain readings under the worst rotational conditions, but no evidence of dangerous stress changes were obtained. The greatest change in vibrational stress was approximately 5000 psi and most changes were much smaller than this amount. The vibrations appeared to be somewhat uniform when the recording paper moved slowly through the oscillograph, but at high paper speeds it was obvious that there was no uniformity to the vibrations. (Fig. 14.) At high paper speeds, the casing vibration rate could be counted also. The 2500 ft of free casing at Well No. 84-21Q appeared to be vibrating at a frequency of between 2000 to 3000 cycles per minute at a rotary speed of 250 rpm.

It should be borne in mind that the casing in both of the test wells was landed in such a way as to have all the casing above the freeze point in tension and at no time during the test was there any slack in the casing above the freeze point. For all practical purposes, it may be said that dynamic stresses in properly landed casing are not dangerous.

● **Effect of temperature and pressure.** Several tests were made to determine the effect of temperature and pressure on the casing, and the results agreed very well with the equations given by DeHetre. These equations are:

$$P = 58.2 \times W \times T \quad \ldots\ldots \quad (1)$$

Where:

P = change in tension, lb.
W = nominal pipe weight, lb per ft.
T = average temperature change, F.

$$P = 0.0434 \times W \times \triangle P \times D/t \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where:

$\triangle P$ = average pressure change, psi.
D = pipe OD, in.
t = pipe thickness, in.

A temperature rise decreases the tension and a pressure rise increases the tension.

The most severe temperature conditions imposed on both wells were those imposed at the time the well was completed. Replacing the oil base mud at 23-11P with 68 F crude oil increased the landing tension to 340,000 lb. Part of this increase was due to pressure effect since the crude oil was circulated down the casing. This tension, neglecting the effect of pressure, was higher than would be expected with such a temperature drop in the top 500 ft. Apparently the cold crude oil cooled the frozen pipe as well as the free pipe, and the average temperature drop in the free and frozen pipe was greater than the temperature drop at the surface. The casing appeared to be free to move through the freeze point even though it had been in the well for about 60 days.

At 84-21Q the gel mud was replaced with water by circulating down the drill pipe. No great increase in tension was noted for this reason.

The landing tension while kicking off well 23-11P is shown in Fig. 15. High pressure gas at 170 F was used to kick off the well, which accounted for the extreme tension drop. At 84-21Q the tension drop was not as extreme as there was a greater length of free pipe in the hole to absorb the effects of the temperature change. Kicking the wells off with gas produced the most extreme tension variation of any operation. It is interesting to note, however, that drilling fluids have from 100 to 200 times the heating or cooling effect of gases. Thus temperature changes in the drilling fluid induce a more rapid change in the casing stresses than would equal temperature changes in injected gases.

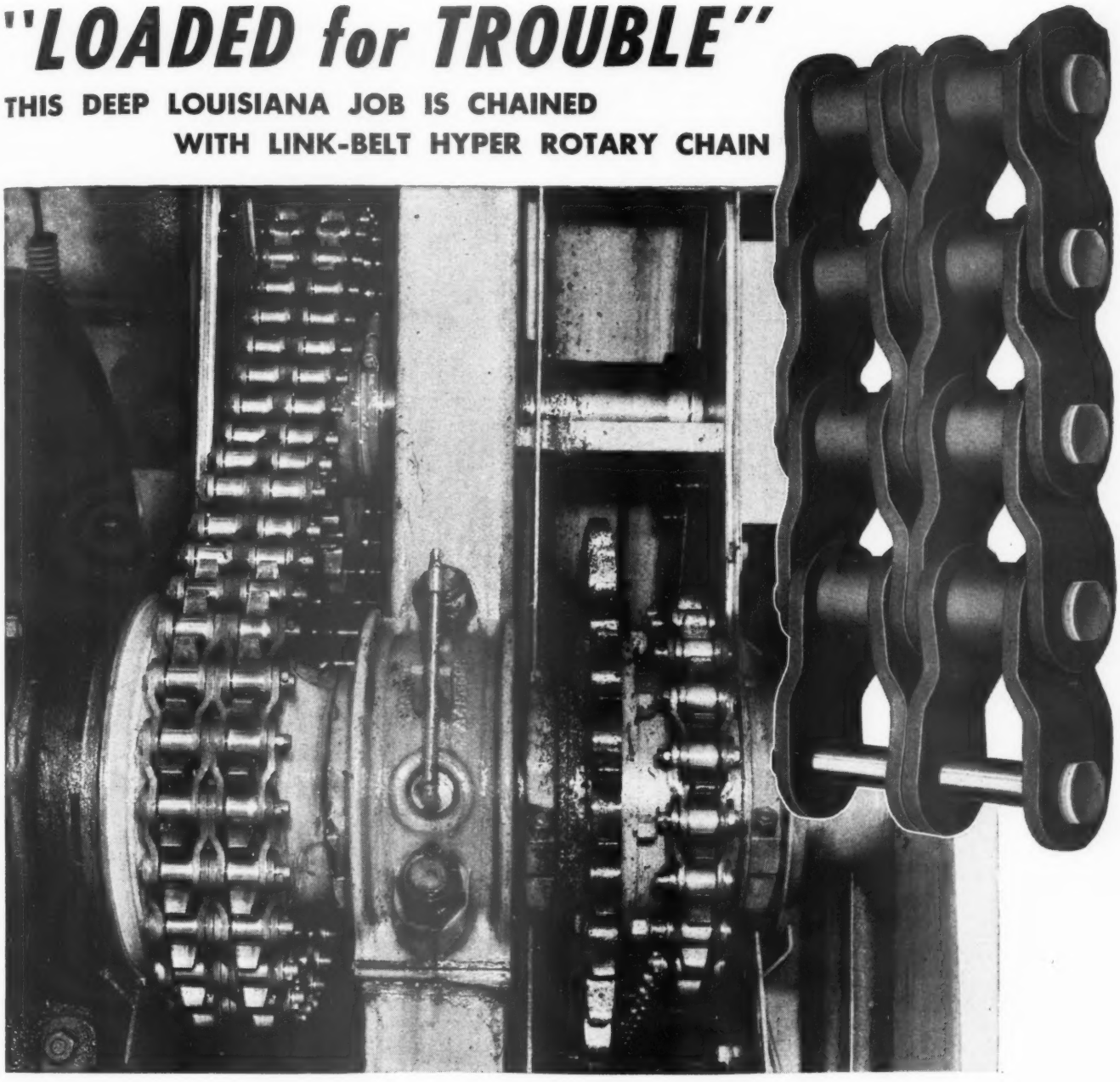
Several conditions were noted during the drilling operations that tended to increase the landing tension. At 84-21Q circulation was lost several times and the tension increased at these times. When circulation was lost while drilling the tension increased in the same manner as when circulation was stopped. When the mud dropped away while pulling or running drill pipe, the tension increased abruptly. This was due to the temperature gradient in the well. Cooler mud moving down the well reduced the average temperature and increased the tension. It was also noted that while the well was standing cemented for lost circulation, the tension increased and was slightly higher just before breaking circulation than it was just before breaking circulation during normal drilling. This condition may have occurred because the drill pipe had a longer time out of the hole to cool off while standing cemented. At times this cool drill pipe condition produced a marked rise in tension while running drill pipe. The maximum increase in the landing tension during drilling operations was approximately 70,000 lb above the equilibrium tension. This corresponds to a temperature decrease of about 38 F. The maximum decrease was approximately 62,000 lb below the equilibrium tension and corresponds to a temperature increase of about 33 F.

● **Trend of tension changes during drilling and producing phases.** The landing tension after landing and during the drilling and producing phases is shown for both wells in Figs. 16 and 17. The solid line in both figures is the landing and tension referred to 100 F for comparison. At 23-11P the landing tension rose abruptly to about its equilibrium value and remained close to it during drilling operations. When the oil base mud was changed to crude oil the high tension probably did not jack the casing up the hole because the whole string of casing was cooled. The low tension as the well was kicked off allowed the casing to slide down the hole but the subsequent low injection temperature of 61 F probably cooled the free pipe enough to jack it up the hole, resulting in a landing tension referred to 100 F that averaged about 25,000 lb, below the equilibrium tension. The lower average casing pressure with gas in the casing as against drilling fluid was also a contributing factor. As the gas injection temperature rose, the casing slid and the tension referred to 100 F approached the equilibrium tension. When this well was shut in after producing a month, the tension rose to 225,000 lb or nearly 25,000 lb above the equilibrium tension.

At 84-21Q the initial landing tension was close to the equilibrium tension. For this reason, the landing tension referred to 100 F showed only a slight change during the drilling phase. The longer amount of free casing in this well did not seem to reflect temperature changes as readily as the casing in 23-11P. After the liner was run, the lap and blank sections had to be recemented to obtain shut-offs. The high tensions during these

"LOADED for TROUBLE"

THIS DEEP LOUISIANA JOB IS CHAINED WITH LINK-BELT HYPER ROTARY CHAIN



. . . . . Leader on the Gulf Coast for Deeper Drilling

Down in the Gulf Coast country, "loaded for trouble" means they have prepared for the toughest drilling with the strongest equipment. And that's why you'll find Link-Belt chains on so many deep Gulf Coast jobs. Take the chain on this deep job, for example. It's Link-Belt SS-3125 Hyper and come what may . . . heavy loads or high speeds . . . it will stay with them, to dependably transit the power for another Gulf Coast location, with staying power for plenty more hole. SS-3125 is Link-Belt's short pitch API drilling chain that's engineered and precision-built to give the strength, durability and safety factor necessary for today's extreme drilling depths typical of the Gulf Coast. That's why so many operators have standardized on Link-Belt SS-3125 Hyper. Yes, they're "loaded" and ready in case of trouble because Link-Belt Hyper is the result of more than 71 years of chain development and improvements.

LINK-BELT

CHAINS AND SPROCKETS

A Type for Every OIL INDUSTRY SERVICE

LINK-BELT COMPANY

Indianapolis 6, Dallas 1, Houston 2,
Los Angeles 33, Kansas City 6, Mo.,
New York 7, Toronto 8.
Distributors in all fields. 10,768

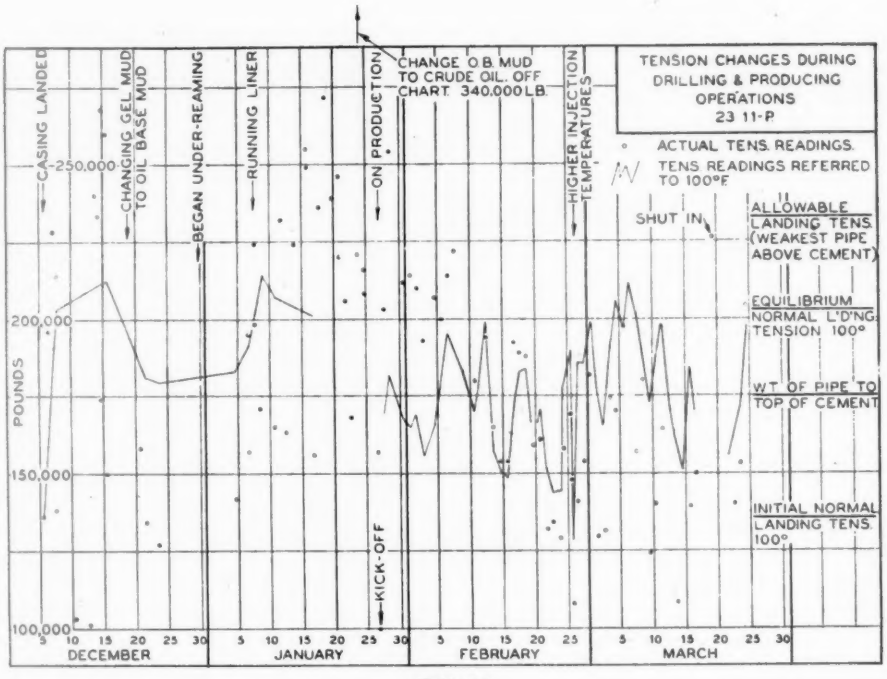


FIG. 16.

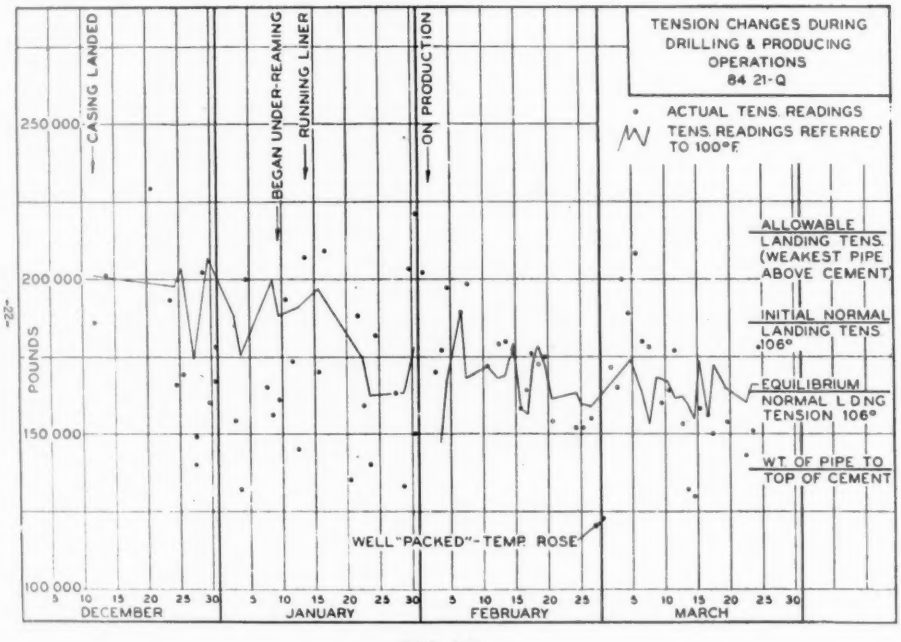


FIG. 17.

operations probably jacked the pipe up the hole causing the drop in landing tension referred to 100 F at that time.

As 84-21Q was produced, the landing tension continued to decrease. This condition may have been due to the lower internal average pressure in the casing as was noted above. On February 28 the flow was switched to the casing and the well was "packed" with gas before opening the casing. Increasing the pressure increased the temperature and allowed the tension to drop to its lowest recorded value. This apparently allowed the casing to slip down through the freeze point because the subsequent tensions referred to 100 F were higher. Continued production at constant rates will probably level out the landing tension slightly below the equilibrium tension; however, as injection temperatures rise during the summer the tension may approach or even exceed the equilibrium.

● **Conclusions.** In establishing a standard casing landing practice, the following must be considered:

1. Landing the casing with a given tension does not assure the operator that the tension will remain the same during the life of the well.

2. Freeze points above the top of the cement may not hold the casing in a fixed position. In choosing a landing tension in such wells, all the casing to the top of the cement should be considered as possibly free to move.

3. It may be impossible to allow for both high tension and buckling when landing the casing in wells that will have large fluctuations in temperature and pressure. Either a compromise tension will have to be chosen or it might be desirable in long strings to cement the casing in an additional place through a cement collar to provide a positive freeze point on which to base the landing tension and allow a diminished landing weight.

4. Dynamic stresses in properly landed casing normally should not be dangerous.

5. Pumping cold fluids into the casing in wells with high landing tensions should be avoided.

● **Acknowledgment.** The authors are indebted to the Standard Oil Company of California for permission to release this paper and they wish to express their appreciation for the aid received from various members of the engineering and managerial staff of the company.

The authors also wish to extend their appreciation to the engineering staff of the Byron-Jackson Company for their assistance in conducting this test.

● **Reference.**

"Casing Landing Practice" by John P. DeHetre, *API Drilling and Production Practice*, 1946.

Appendix

A. Derivation of equations:

(1) The change in length of steel under stress measured in feet within the elastic limit is:

$$e_s = \frac{PL}{AE} \text{ or } P = \frac{e_s AE}{L}$$

The relationship between nominal weight and plain end area of casing is closely approximated by

$$A = \frac{W}{3.458}$$

$$\text{Thus, } P = \frac{e_s W E}{3.458 L}$$

$$\text{But } E = 30 \times 10^6$$

$$\text{Therefore } P = \frac{e_s \times W \times 8{,}675{,}000}{L}$$

(2) Other formulae used were taken directly from DeHetre's paper.

B. Nomenclature:

P = change in load at landing head, lb,

W = nominal weight of casing, lb per ft,

$\triangle T$ = average temperature change, F,

D = diameter,

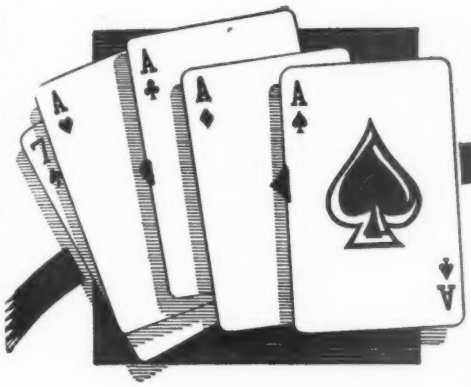
t = thickness,

$\triangle P$ = average net pressure change, psi,

e_s = total change in length due to stress, ft,

L = length of free pipe, ft.

★ ★ ★



A GOOD COMBINATION

BREWSTER *MATCHED* DRILLING EQUIPMENT

Like four aces in a poker game, Brewster *Matched* Drilling Equipment is a good "blue chip" combination.

FOR DRILLING TO 4500'

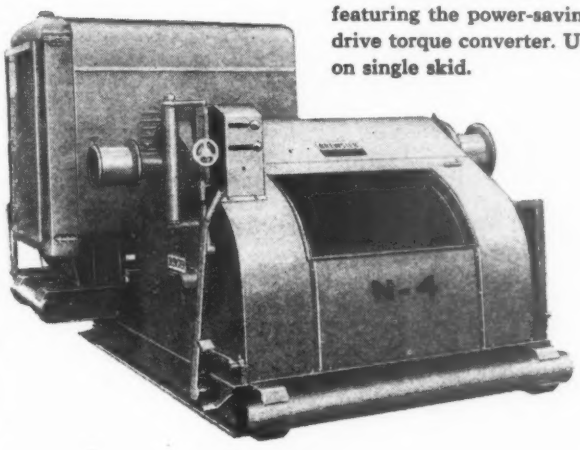
use this dependable quartet, designed and built to work together. Brewster offers the advantage of MATCHED equipment—each piece individually superior... together a well-balanced, efficient team.

Brewster also builds drawworks and additional equipment for drilling to 7,000 or 10,000 feet. Write for complete information about Brewster *Matched* Drilling Equipment.

H-50 HOOK BLOCK
compact, short coupled block with 50-ton capacity. Hook locks in positions.

4-S SWIVEL
the tough Brewster swivel with 120-ton capacity. Dependable, smooth operating.

N-4 DRAWWORKS
featuring the power-saving fluid drive torque converter. Unitized on single skid.



OB 18 OILBATH ROTARY
Full 18" table opening, ideal for drilling to 4500'. Lightweight and well-built.

SOLD BY THE SUPPLY STORES:

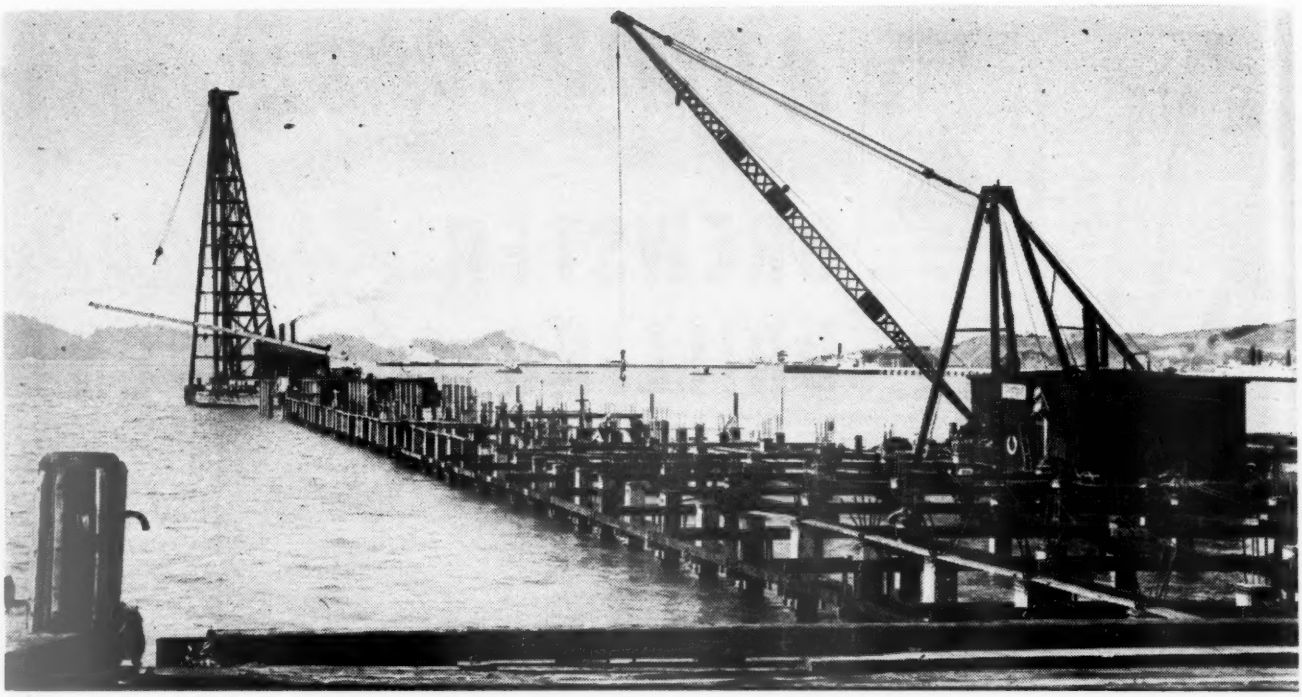
In the Mid-Continent Area:
BOWEN SUPPLY CO. • REAMS SUPPLY CO.
INDUSTRIAL SUPPLY CO.

In the West Coast:
LEE & BRYSON, INC.

Export Office:
BAIRD SUPPLY CO., 420 Lexington Ave., New York 17, N. Y.

BREWSTER *Drilling Equipment*

THE BREWSTER CO., INC.
SHREVEPORT, LOUISIANA, U. S. A.
For Over 30 Years Manufacturers of Crown Blocks, Traveling Blocks, Oilbath Swivels, Oilbath Rotaries, Unitized Drawworks, Winches.



Floating pile driver at end of wharf lifts and lowers pre-cast concrete piles. As piles are set, floor of wharf is extended.

Remodeling Richmond refinery "long wharf"

Petroleum Engineer Picture Story

THE remodeling and modernization of Standard of California's Richmond Refinery "Long Wharf," begun last August, is now well under way. At the present rate of construction it is expected that the job will be completed by the beginning of 1948.

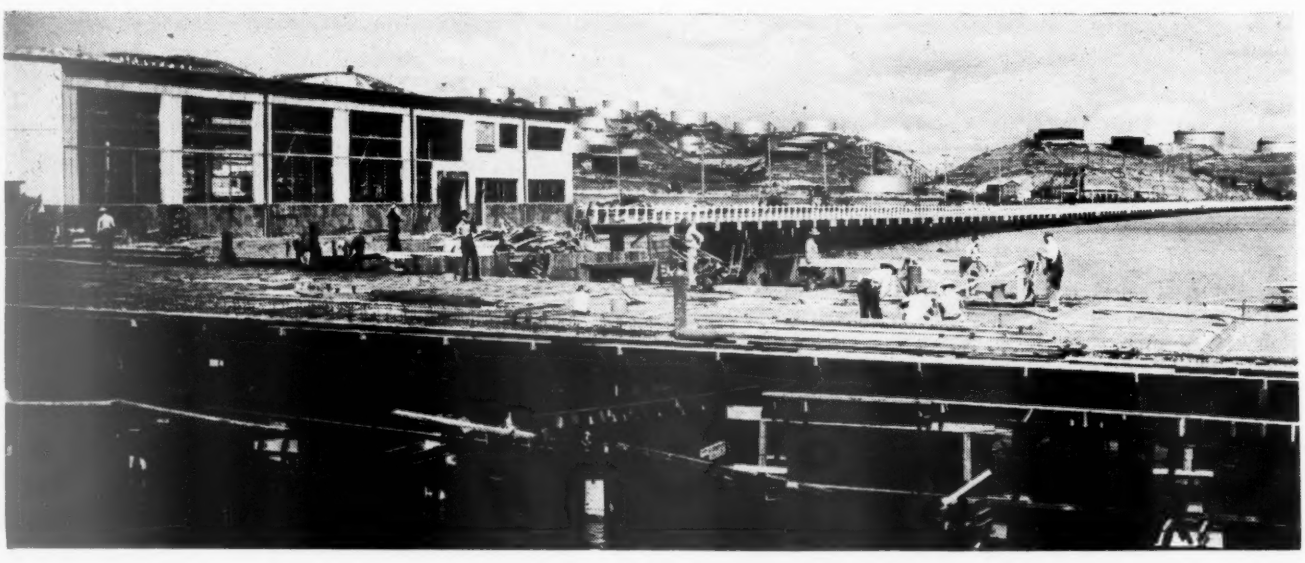
EXCLUSIVE

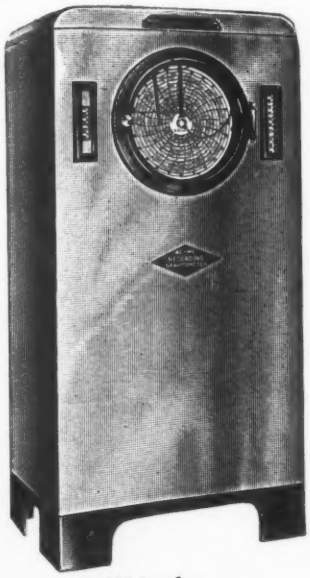
Provided for in the plans are a truck causeway, enlargement of the pier to increase docking space from the present three deep-water berths to five, and reconstruction of the repair dock, office building, machine shop, and warehouse.

The loading section of the wharf will be lengthened from its present 1516 ft to 2467 ft and its width will range from 112 to 135 ft. Piling and understructure is of pre-cast reinforced concrete piles and pre-cast deck slabs with monolithic concrete deck.

At the top is a view of the floating pile driver as it lifts a 90-ft. pre-cast concrete pile during work extending northern end of the wharf.

Below is a scene showing men preparing to lay cement for new repair wharf. In the left background is the new machine shop, which will house facilities now on a floating barge. Extending off to the right in the picture is the recently completed causeway, which connects loading face of wharf with land.





Write for
Catalog No. 30-A

AC-ME RECORDING GRAVITOMETER

COMPLETE VISIBILITY
EXTREMELY SENSITIVE

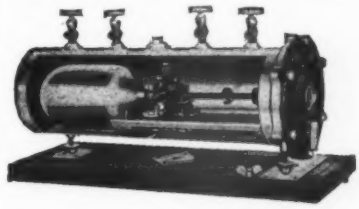
This instrument accurately records the changing gravity of gas and automatically corrects for variation in barometric pressure and temperature.

Sturdy construction and simplicity of operation contribute to accurate operation with a minimum of maintenance.

The instrument does not contain rotating parts thereby eliminating a major source of wear. The accuracy and practicability of Refinery Supply Company equipment are the result of scientific and sound manufacturing procedures combined with materials of proven integrity.

Complete Line of
Scientific Laboratory Equipment

GAS GRAVITY BALANCE



Gives dependable and accurate results on wet gas, dry natural gas and artificial gas. In determining the specific gravity of gas, will give results that can be checked within 3 points in the fourth place.

Each unit is completely equipped with needle valves and carrying case.

Designed for laboratory, plant and field

THE REFINERY SUPPLY CO.

Main Office and Plant
621 E. 4th Street **TULSA, 3, OKLAHOMA** Ph. 4-8144, L.D. 581

— Houston Office Temporarily Discontinued —

DEAN BROTHERS PUMPS INDEANAPOLIS, INDEANA. PUMPING MACHINERY. INC.

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W. TENTH ST.

PUMPS

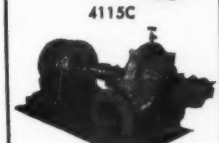
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL

4088

4057A

4115C



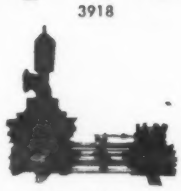
8000C

8001

RECIPROCATING

942

3918

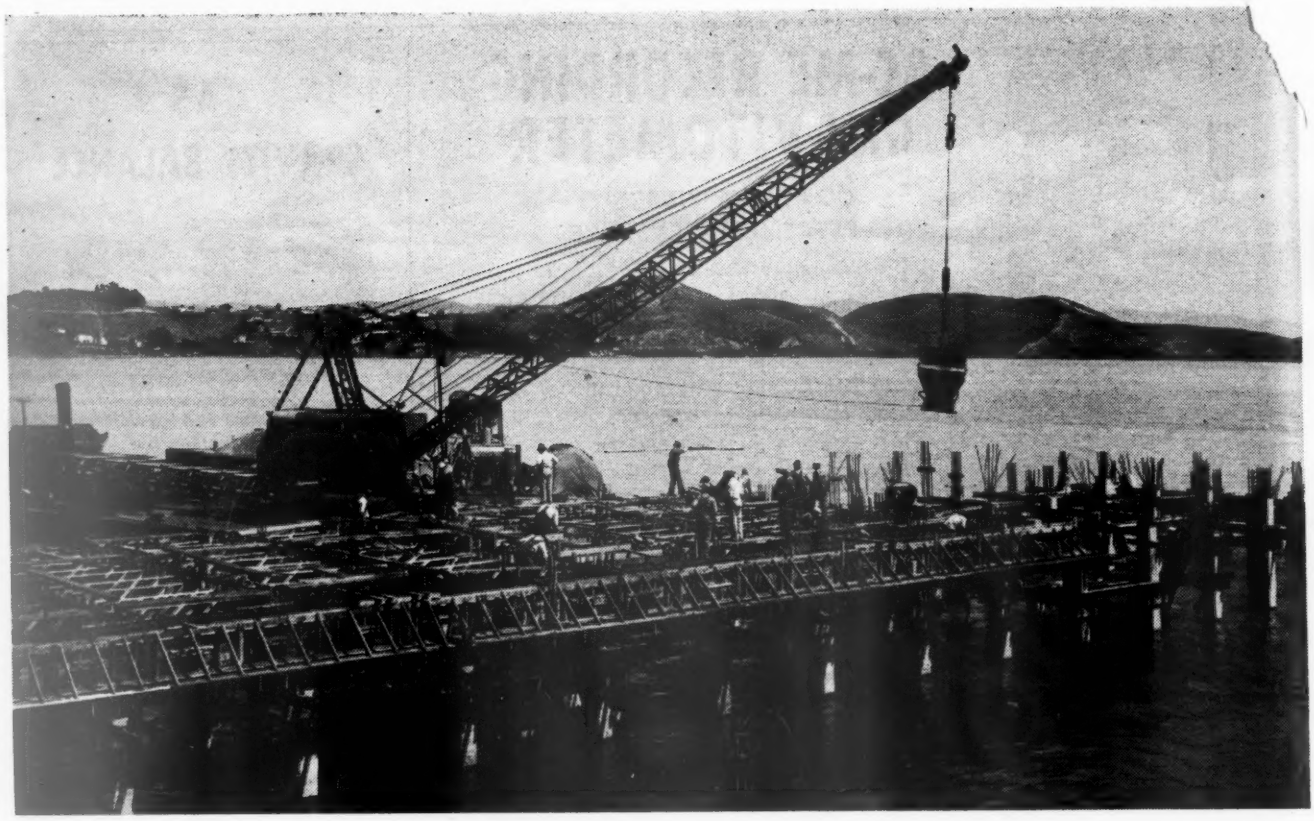


2446

2352L

3833

BRANCH OFFICES: NEW YORK HOUSTON



Pouring cement on the new repair wharf of Standard of California's Richmond Refinery Long Wharf, a distribution point.

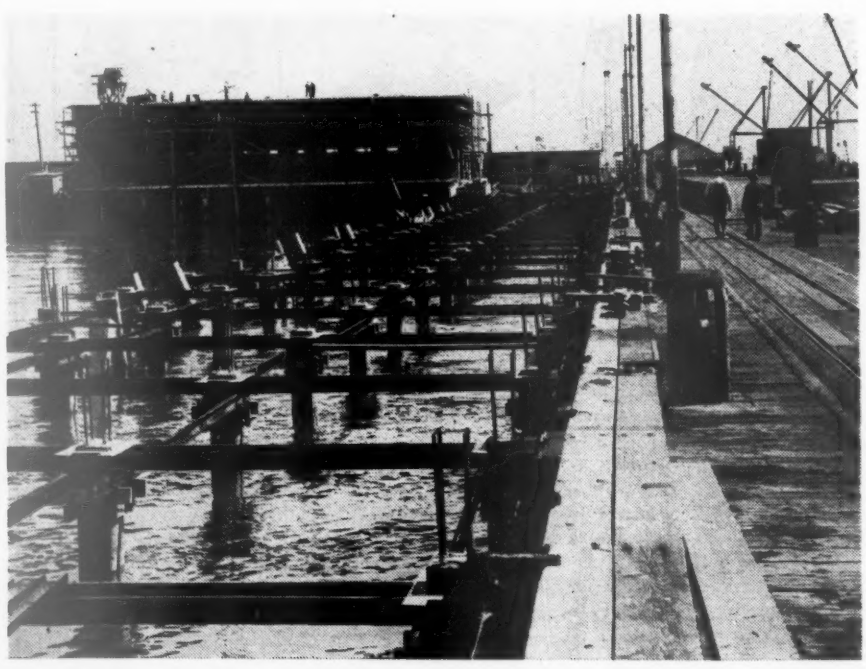
Virtually all units of the present wharfing facilities will be rehabilitated and many of them are being replaced. When the program is completed, the reconstructed wharf is expected to rate among the best of its kind, according to company officials.

The mile-long asphalt surfaced causeway, now complete, provides two wide truck lanes. It is constructed of pre-cast reinforced concrete slabs built over pre-cast concrete piles. The roadway is being used by the contractors but has not yet been opened to operating traffic.

When the main wharf structure is completed, the causeway will permit elimination of the narrow gauge electric railway, now employed by the company for transportation of personnel, equipment, and packaged products to the face of the pier. The railway, one of the oldest installations at Richmond, was first put into service on the "Long Wharf" in 1903.

There will be four deep-water berths for bulk loading on the outer face and one on the inner face, as well as space for six barges. New lighting arrangements will facilitate night operations.

The "Long Wharf" houses the marine loading facilities for Standard's Richmond Refinery and during the war was one of the major coastal distribution points for the shipment of petroleum products, critically needed in the Pacific. ★ ★ ★



Expansion of Standard of California's Richmond Refinery Long Wharf includes a widening of the loading face of the pier as shown in the scene at left. In the background is pictured the nearly completed office building. During the war Long Wharf had an important share in the shipment of petroleum products to the Pacific areas.

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* Engineer
Irwin-Keasler Building
Dallas 1, Texas

NEW EQUIPMENT

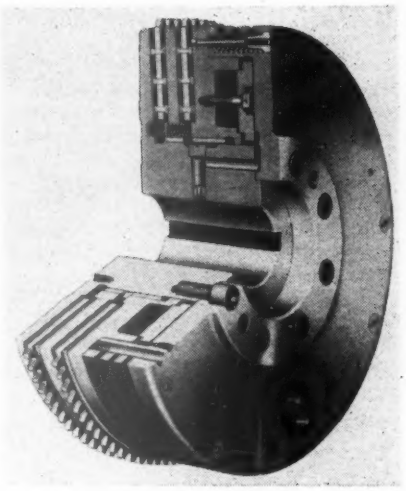
(1) Air-actuated clutch

A new air-actuated clutch, the Model PH, has been designed and is now being built by the Twin Disc Clutch Company of Racine, Wisconsin. This clutch is available in 30 in., 36 in., and 42 in. sizes.

The new Model PH clutch supplements the regular line of Twin Disc Model P air-actuated clutches and widens the range from which petroleum operators may select units to fit their needs. Sizes of the two models of air-operated clutches now run from 14 to 42 in. with capacities from 75 hp to 1325 hp. Torque ratings range from 900 ft-lb to 89,550 ft-lb.

These new high torque ratings have been obtained by modifying the basic Twin Disc air-operated clutch design to permit increased air cylinder areas, thus making the Model PH clutches ideal for drum drives and other oil-field applications, according to the manufacturer.

All Model PH clutches are equipped with heavier, new-type spline tooth con-



struction on the clutch hub, center plates, and floating plates. To counteract heavy shock loads and to reduce gear teeth wear, Model PH-36 and PH-42 clutches also are built with a two-piece hub and back plate construction. The hub is made from a steel forging and the back plate from special alloyed cast iron.

The air-actuated clutches operate by remote control without a complicated linkage system and shaft space is greatly reduced. They offer ideal operating characteristics because any desired amount of air pressure, within certain limits, can be applied to the friction plates to provide either slow or fast engagement, it is pointed out.

Because of its relatively few moving parts and the fact that no adjustment is ever required to maintain proper pressure on the friction disks, the new Model PH presents very few maintenance problems. Complete and adequate lubrication is provided by oil entrained in the actuating air.

(2) Synchronous motors

Two special 300-hp, 240-rpm inert-gas-filled synchronous motors now being built by the General Electric Company for use in an inflammable atmosphere incorporate all necessary features into one simple, smooth design. The enclosure has built-in coolers and a sealed chamber that is filled with a noncombustible gas. The gas is under sufficient pressure so that any leakage will be outward and no air or inflammable gas will get into the motor.

By removing only one access cover, the field leads, stator leads, terminal boards, and bridge resistors for the temperature relay are all within easy reach. There are no bumpy terminal boxes to mar the smooth external lines of the motors.

The inert gas follows unrestricted flow lines in the cooler, which is situated over the motor, to give efficient heat transfer. The cooler can be removed for inspection or maintenance.

Resistance temperature detectors are imbedded in the stator windings. They are used with a temperature relay to remove the motor from the line in the event that the maintenance man forgets to turn on the cooling water, or if the temperature of the stator windings becomes excessive for any other reason.

(3) Rotary hose

A new rotary hose, known as Goodall "Flexo," has been announced by the Goodall Rubber Company, 1606 Maury Street, Houston, Texas.

Based on a new method of construction, this new hose is extremely strong and flexible. It can easily be bent in loops 30 in. in diameter without the slightest damage or measurable distortion; yet it holds full test pressure with minimum elongation, according to the manufacturer.

Goodall "Flexo" rotary hose can be handled without special precautions. Its flexibility makes the loading rack unnecessary.

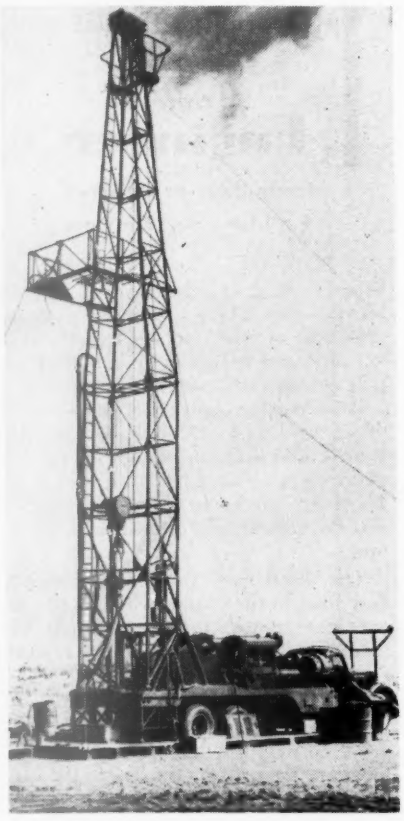
A new "Streamlined" Barney coupling is used on the new hose. This coupling weighs one-third less yet loses none of its strength. The coupling is still the strongest part of the new hose.

Goodall offers two extra services to further reduce hose costs. The first is a repair service in Houston where worn hose is renewed at a fraction of the cost of a new hose. The second is a trade-in allowance for Barney couplings.

(4) Failing 2500 Holemaster

Featuring streamlined design and lightweight construction, the new Failing 2500 Holemaster drills are beginning to come off the production line of the Geo. E. Failing Supply Company of Enid, Oklahoma, and Houston and Midland, Texas.

Engineering for the new model drill was done throughout the war years and officials of the Failing company recommend it as the "finest equipment of its type" they've ever built.



The 2500 Holemaster is designed for core drilling, deep exploration holes, electric logging, water wells, mineral exploration, and slim-hole production to a depth of 4000 ft.

One of the outstanding features of the new drill is the easy accessibility of all working parts and a new balanced crown block insures more even loading of the mast legs. The mast itself is sectional and so designed that additional length may be added without alterations to the mast. The lightweight, all-steel, oil-bath rotary table is easily removed and adapted to special drive and table stand for rathhole drilling.

The new type double drawworks is actuated by two air clutches. A patented floating gear box gives smooth application of power to the drawworks and rotary table. The heavy duty transmission provides four rotating speeds and one reverse. Dual engines are coupled through a special hydraulic cushion drive that makes possible any drive application from individual, to compounding of engines to drill and pump. Hydraulic throttles are provided that give perfect synchronization when the motors are compounded. The duplex 5x10 reciprocating mud pump is unitized with the drill and fingertip air controls are grouped for ease of operation.

(5) Maltese Cross belting

Hewitt Rubber Division, Hewitt-Robins, Inc., announces that Maltese Cross conveyor and elevator belting again is in production after being withheld from manufacture during the war because of government restrictions on the use of premium quality materials.

Construction features of the belting, which give it extra strength, great flexibility, and long service life include:

1. Special Hewitt-developed rubber compounds that supply maximum resistance to abrasion, weathering, aging, heat, and sun-checking.
2. Selected staple cotton reinforcements to provide added strength and reduce stretch to a minimum.
3. High flexing qualities, and resilient rubber frictioning between plies to assure maximum adhesion.
4. Scientific treatment of the entire belt carcass against mildew to eliminate this common cause of belt failure.
5. Layers of highly elastic skim rubber provide added cushioning to withstand shock loads, increase flexibility and assure perfect troughing.
6. Tough cover is anchored to carcass by special Dura-Bond breaker strip.

Maltese Cross belting is offered in straight-ply, stepped-ply, and shock-pad construction. The latter is recommended for unusually brutal service.

The belting also is available in a special construction suitable for handling hot materials, it was announced.

Hewitt continues to recommend Monarch neoprene belting where oil-resistance is an important factor, as Maltese Cross is not intended for this type of service.

(6) Plug gate valves

Crane Co., Chicago, announces a new line of corrosion-resistant plug gate valves that are unusual in that they combine the advantages of the two most important basic types of valves. The new design provides straight-through flow in the wide-open position as do conventional gate valves, yet it is as suitable for throttling service as conventional globe valves.

Extensive tests conducted in the Crane Research Laboratories and in the field have established the following advantages for the plug gate valves, according to the manufacturer:

(1) They offer very little resistance to flow in the wide-open position, having a maximum discharge equal to that of a wedge gate valve and about twice that of a globe valve.

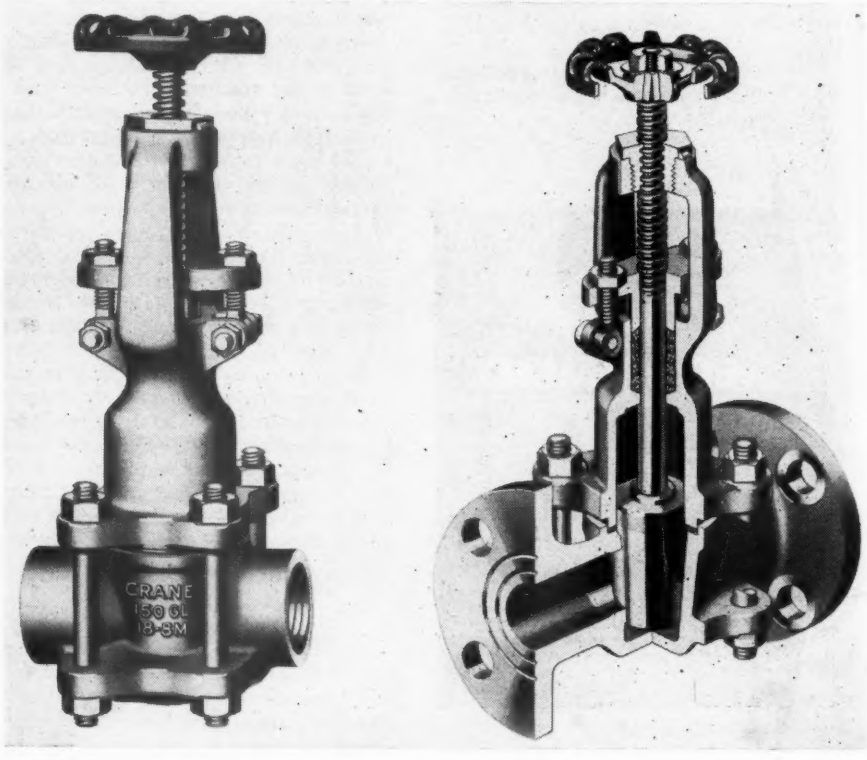
(2) The design permits very close throttling at both high and low velocities.

(3) Resistance to cutting action of the fluid when in a throttled position is equal to that of conventional plug type globe valves.

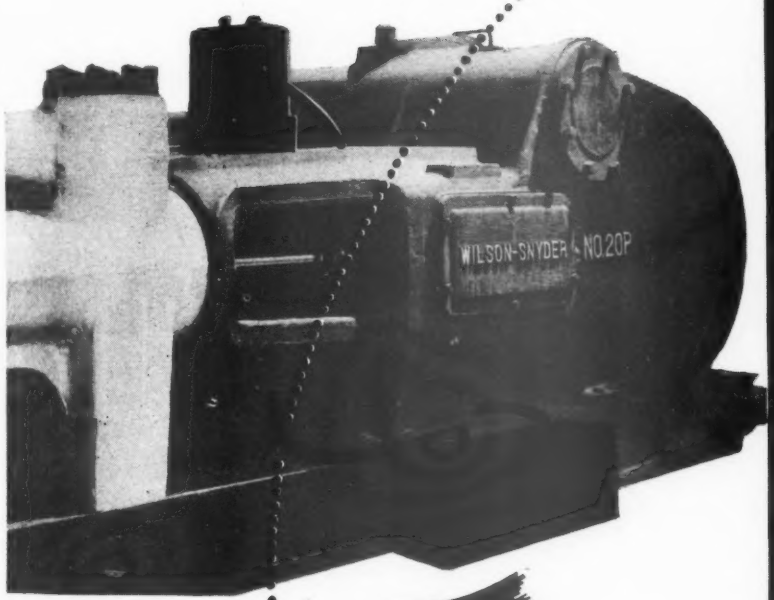
(4) The valve is not subject to sticking in the closed position, even though it be closed while hot and opened when cold.

(5) There is no tendency to galling.

Of outside-screw-and-yoke design, the new Crane plug gate valves have bolted bonnet joints and are available with either screwed or flanged ends in sizes from ½ to 2 in. They are regularly supplied in either 18-8 Mo or Monel metal. For particular corrosive conditions they can also be made in various other alloys to customer's specifications.



Now... POSITIVE OIL LUBRICATION for SLUSH PUMP RODS



The WILSON "Little Gusher" LUBRICATOR

- This lubricator is made of aluminum and is mounted above pump rods (as shown at left). There is only one working part, that is the float operated toggle valve in the upper chamber.
- The Sump (also shown at left) receives all excess lubricant which is returned to the lubricator for continuous use.
- Lubricator may be put into operation before starting the pump—eliminating any dry strokes of the rods.
- By use of the Wilson "Little Gusher" Lubricator life of Slush Pump Rods is increased many times and costly shut down time reduced to a great extent.

Every Pump on Every Rig Needs One!

Contact Your Nearest Wilson Supply Store or write

WILSON SUPPLY COMPANY

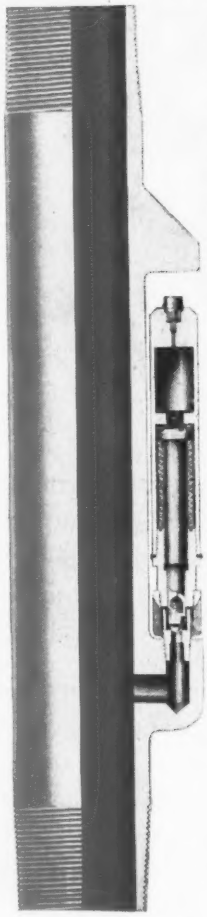
1412 MAURY ST., HOUSTON, TEXAS

SALES OFFICES: Tulsa, Oklahoma; Dallas and San Antonio, Texas. LOS ANGELES: Western Pressure Control, 5700 Santa Fe Ave. TRINIDAD, B. W. I.: Neal Massey Eng. Corp.

BRANCH STORES: TEXAS — Beaumont, Kilgore, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi, Columbus. LOUISIANA — Lake Charles, New Iberia, Harvey, Shreveport. ARKANSAS — Magnolia. MISSISSIPPI — Natchez.

(7) Gas lift valves

GOT Type "O" gas lift valves, manufactured by Garrett Oil Tools, Longview, Texas, are pressure-charged, bellows type valves that may be used to produce low or high volume wells of any depth. The valves are extremely simple and, because of full protection afforded the bellows, will give long service.



Type "O" valves consist of an outer housing of stainless steel or monel that contains a seamless monel bellows, valve stem, and replaceable valve seat. The valve stem is permamently connected to the top of the bellows. During assembly of the valve, a non-compressible liquid is introduced around the outside of the bellows; the "pressure - dome" above the bellows then is charged to desired pressure and sealed. This pressure is exerted on the outside of the bellows and compresses it to keep the valve stem on its seat under predetermined casing pressures.

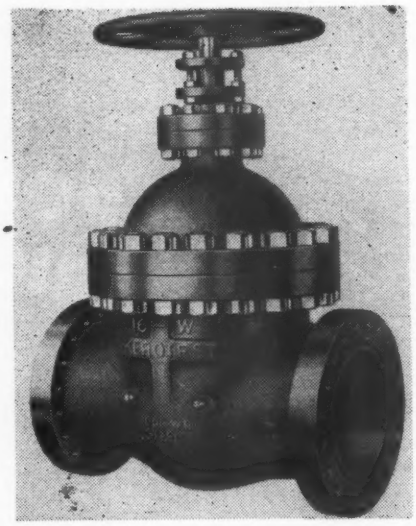
Under high casing pressures the valves are in full open position, with the reinforcing column of liquid sealed around the outside of the bellows to prevent undue differential pressure across the bellows. Inside, the bellows are supported and guided by the valve stem.

GOT Type "O" valves are externally mounted on mandrels that fit into the tubing string, thus leaving a full opening through the tubing.

(8) Drilling valves

An improved, completely pressure-lubricated drilling valve has been announced by Kerotest Manufacturing Company, Pittsburgh, Pennsylvania.

Kerotest's current drilling valve production provides for high pressure lubrication of the wedge seats and the stuffingbox. The specially constructed Alemite lubrication fittings have been scientifically placed on the valve body and stuffingbox to prevent damage during handling on the derrick floor or in transit, it is stated. Special construction of the lubricator fittings permits them to take the lubricating gun directly. An



internal and an external seal prevents leakage or blowouts under heaviest pressures.

Stuffingbox lubrication reduces wear on the stem, eases operation, and gives additional lubrication to the packing. On the wedge seats, the lubrication adds seal against leakage, provides for easier movement, and reduces opportunity for corrosion.

(9) Marley Aquatower

The Marley Company, Inc., Kansas City, Kansas, is offering the new Aquatower to the air conditioning and refrigeration field as an answer to the demand for a compact cooling tower of modern design with a high performance rating. Completely assembled at the factory, the Aquatower is sent out as a "packaged product" ready for operation.

Features are:

Designed with standard components, no special pumps or motors to return to the manufacturer for service.

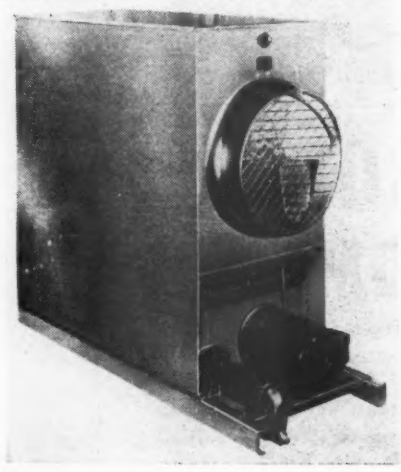
Engineered for indoor or outdoor service.

Heavy steel integral welded case painted aluminum.

Sized from 3 tons to 15 tons of refrigeration.

Available with or without pumps.

All component parts readily accessible for servicing.



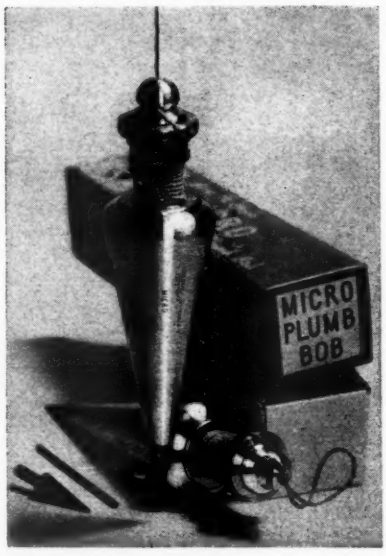
Field tested for several years.

Sturdy fan guard insures safe operation.

Complete operation and maintenance instructions provided.

(10) Plumb bob

A quick-acting, precise plumb bob is announced by Suverkrop Instruments, Bakersfield, California. It has a rotatable reel and special hook on top of the neck. A cord is reeled off to the approximate length wanted, then slipped into the hook, which holds the bob exactly centered anywhere on the cord. The bob can then be minutely adjusted



up or down simply by rotating the spool. When not in use, spool and hook hold the cord neatly and securely in place, even with the bob carried loose in the tool box.

This plumb bob is carefully engineered and thoroughly field-tested, it is stated. It is made of dense, forged brass, and has a point of finest steel, properly heat treated for toughness and hardness, and fitted to insure against loss. The spool has 30-ft capacity.

(11) LPG service valve

Designed for high pressure liquefied petroleum gas service, the new "N-M-D" (non-metallic disk) bronze valve is announced by The Lunkenheimer Company, Cincinnati, Ohio. The valve is made in globe, angle, and check patterns, sizes ¼ in. to 3 in., screw ends.

The valve is ruggedly constructed to safely withstand pressures up to 400 psi w.o.g. Disk and stem packing are especially compounded for LPG service. Recommended for use on liquefied petroleum gas systems, bulk transfer and storage tanks, domestic cylinder charging manifolds, vapor differential compressors, and general industrial uses.

A back seat above the stem thread permits repacking the valve under pressure when wide open. The disk can be renewed with a minimum of time and trouble. All other parts of the valve are also renewable, if necessary.

PALOMA FIELD TESTS SHOW 2 to 3cc API LESS WATER LOSS

WITH CYANAMID'S *Aerotan*

NEW WATER LOSS CONTROL REAGENT

Company A reports . . . in the Paloma field of California, test wells using AEROTAN* exclusively are showing excellent results. Typical is a well drilled by Company A—a deep hole 11,700 feet, of which 10,600 feet was uncased. AEROTAN was the only water loss control reagent used in drilling this well. Drilling was through formations typical of most of the adverse conditions to be met in California . . . bentonitic shales, sluffing shale, hard chert, high temperatures—145/150° F. at the flow pipe, 200/220° F. bottom hole. In spite of the large amount of open hole no tight spots were encountered, filter cake was excellent, and the average water loss was from 2 to 3 cc API lower than average for the district.

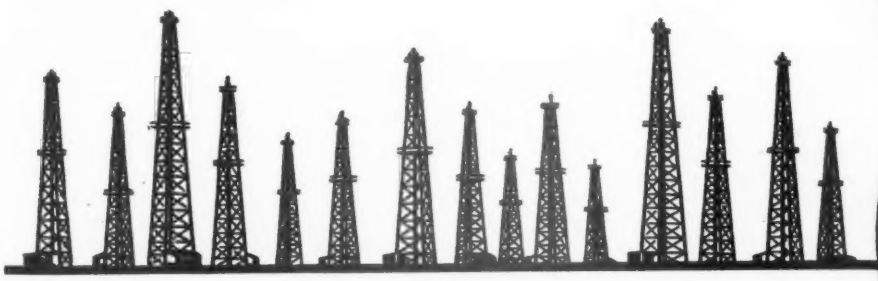
Company B reports . . . similar results were obtained with AEROTAN by Company B, also in the Paloma field. This was a 12,000 foot hole, 11,750 feet of which was open hole. Here again no tight spots were encountered. Temperature ran about 122° F. at the flow pipe. Water loss averaged about 1 cc API lower than normal for the district.

AEROTAN has also shown definite superiority in the treatment of cement contaminated mud . . . a differenee as great as 4 cc API in comparison with other reagents.

These AEROTAN results show that AEROTAN offers *improved* water loss control *plus* practical savings in handling and application. Our technical advisers will be glad to help you determine whether AEROTAN will give you equally satisfactory results under your specific drilling conditions. For further information write American Cyanamid Company, 229 Shell Building, Houston, Texas, or Azusa, California.

*Trade-mark

When Performance Counts—Call on Cyanamid



AMERICAN Cyanamid COMPANY

Industrial Chemicals Division

30 ROCKEFELLER PLAZA • NEW YORK 20, N. Y.

AEROTAN *is liquid*

. . . cuts time and costs

AEROTAN is a viscous liquid supplied in small drums or wooden kegs. Can be applied directly to the mud stream without waste of time or material. Thoroughly laboratory and field tested both on an experimental and commercial basis, AEROTAN is completely soluble—entirely absorbed by the drilling mud without loss to the formation . . . no heat is required for complete solution . . . and it is not adversely affected by high temperatures.

GEN. MUD SAYS...

"Down by the old mud stream is where I first met AEROTAN", says General Mud. "And that's where you'll find real economies in AEROTAN's ease of handling and application. Let Cyanamid tell you more about this new water loss control reagent."

(12) Tubing elevator

Web Wilson Oil Tools, Los Angeles, California, has broadened its line of center latch elevators for tubing by the addition of the new type "CT." This elevator is available in all sizes up to and including 4½ in. diam. The elevator features the same high strength manganese-molybdenum steel as is used in all other Web Wilson elevators with the result that the type "CT" has a capacity

Elevator as shown is supported in a set of 2¼-in. elevator links.

of 50 tons at a weight of 53 lb for sizes up to 3½ in., and 64 lb for the 4½ in. size.

The type "CT" elevator is the only elevator in its class that will operate with 1¼ in. to 2¾ in. elevator links and has the exclusive Web Wilson feature of automatic spring-actuated opening when the latch is operated, according to the manufacturer. This makes for speed in getting the elevator off the tubing, both for the derrickman and the crew on the derrick floor and makes the elevator ride in a balanced operating position when empty. The operating handles have been made amply long to provide ease in operation and a pressure lubrication fitting on the main hinge pin eliminates difficult opening and closing.

(13) Beckman UltrOHMeter

The National Technical Laboratories, South Pasadena, California, designers and manufacturers of the familiar Beckman pH meters, Beckman spectrophotometers, and other precision instruments, announces production of the newly developed Beckman UltrOHMeter.

This instrument will allow precision measurements of unusually small currents and high resistances with the ease and convenience of ordinary test equipment. Current sensitivity to as low as 2×10^{-13} amperes full scale, permits resistances as high as $1 + 10^{16}$ ohms to be measured directly. The high current sensitivity makes possible the measurement of high resistance in such applications as capacitor leakage tests, under the actual conditions of operation. Thus, it is no longer necessary to extrapolate from high voltage tests, which is often objectionable because severe polarization and unpredictable voltage coefficients may be encountered.

A built-in standard voltage source

provides voltages for resistance measurements in convenient steps from 0.5 to 20 volts and the instrument is so designed that resistor linearity tests and polarization checks can be made conveniently.

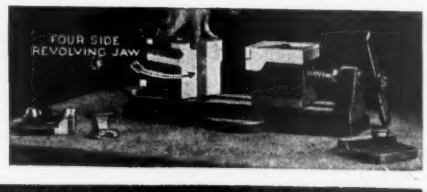
By use of voltage feedback, the time response of the instrument is maintained at approximately 2 seconds despite the use of input resistors varying from 10^6 to 10^{11} ohms.

The Beckman UltrOHMeter can also be used as a high impedance d-c voltmeter with sensitivities from 20 mv to 5.0 volts with a maximum of 10^{11} ohms input impedance.

Other important features of the Beck-

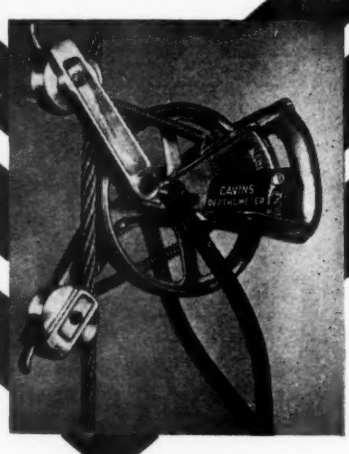
SAVING TIME ON 1000 JOBS

You can eliminate a daily loss of many hours of the time of your highly-paid Machinists if you allow these men to use THE JACKSON TIME-SAVING VISE. This extremely economical tool enables your men to set up work on the Drill Press, Miller, etc., in but a fraction of the regular time, because they will no longer be obliged to hunt for Clamps, Angle Plates, Parallel Strips, Bolts, Washers, etc., customarily used in "rigging up" to hold THE THOUSAND AND ONE ODD SHAPES that arise annually in Machine Shop work. The cuts show how the four-side revolving Turret Jaw and the Auxiliary Jaws hold work high, low, vertically, horizontally, or at an angle. Also how the Vise readily serves as a low-cost Jig for the interchangeable drilling of similar bolts, pins, etc. Over 12,000 of these Vises are daily saving money for their owners. Send for Bulletin No. 23-A.



BROWN ENGINEERING CO.
133 NORTH 3RD ST. READING, PENNA.

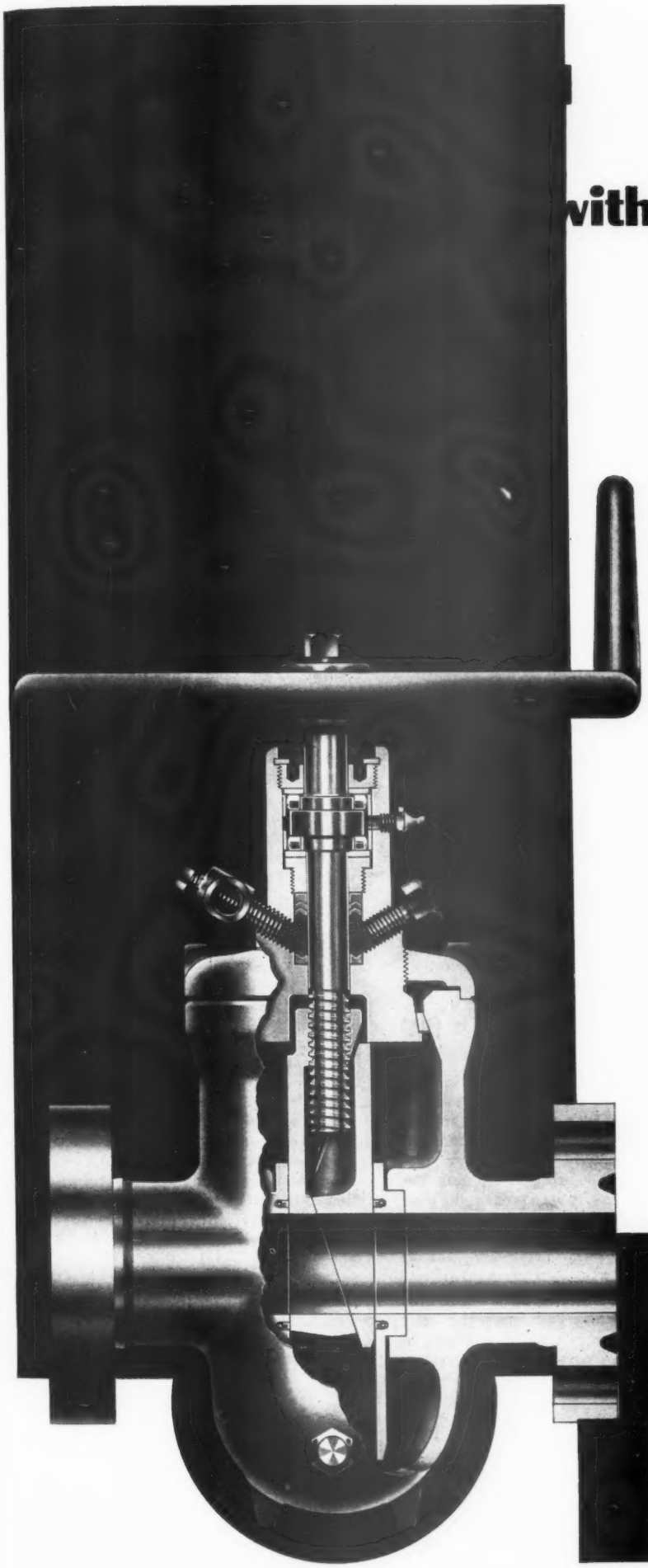
NOW YOU CAN EASILY TAKE ACCURATE WIRE LINE MEASUREMENTS



THE CAVINS DEPTHOMETER

will tell you where bottom is in little more time than it takes to make a trip with your bailer Gives you accurate depth in plain figures—compensates for raising and lowering tools when feeling for bottom Strong, light-weight, easily used, and priced right Send today for illustrated folder.

THE CAVINS CO.
2853 Cherry Ave., Long Beach 6, California



with a *Pressure Seal Bonnet*

The new and improved W-K-M Flow-Line and Christmas Tree Valve has all the features operators have preferred in the past . . . plus these other new and exclusive features that keep W-K-M Valves tops in oilfield valves.

PRESSURE SEAL BONNET: Self-adjusting to pressure and temperature changes. There are no flanges, no studs and nuts.

DOUBLE ROLLER thrust bearings on stem for ease of operation. Stem threads are precision ground.

CHROME plated gates.

COMBINATION plastic-chevron packing—uses no gland or gland follower.

LUBRICANT contained in entire body—no special lubricant required—seal does not depend on lubricant.

THROUGH-CONDUIT opening—no turbulence—no restriction of flow.

PARALLEL expanding gates—seal directly across both seats with no distortion whatever—positive shut off both sides.

OVERSIZE bronze renewable seats.

COMBINATION wipe and seal rings keep the gate clean . . . pressure out . . . grease in.

W-K-M Company, Inc.

OIL FIELD, PIPE LINE & INDUSTRIAL EQUIPMENT

HOUSTON, TEXAS, U. S. A.
LOS ANGELES

Cable Address: "WILKOMAC"
Export Office: 30 Rockefeller Plaza, New York, N. Y.

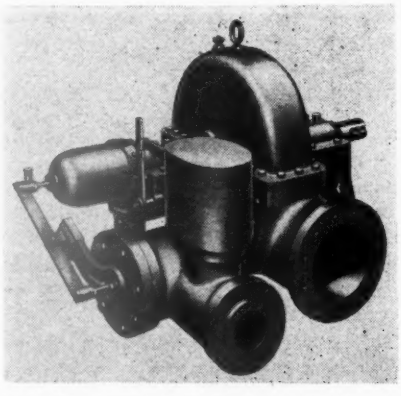
man UltrOHMeter are: Internal resistor calibration means, generous range overlap (23 ranges), minimum current sensitivity of 5 micro-amperes, minimum resistance of 100,000 ohms, and both positive and negative signals can be measured.

The instrument is completely battery-operated and is supplied in a sturdy walnut case with a built-in shielded compartment.

(14) Elliott turbine

Elliott Company, Jeannette, Pennsylvania, is announcing a new YR line of mechanical drive turbines. This line of turbines continues all the advanced features of the Elliott Y line of turbines, thousands of which are now in operation in practically every industry in the country.

The new YR turbines also incorporate increased capacities (up to 2000 hp), higher allowable steam pressures and temperatures, higher allowable



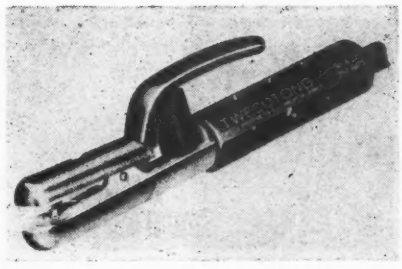
back pressures (through 250 psig), higher operating speeds (through 6000 rpm), and in general greater flexibility, according to the manufacturer.

The turbines have been made suitable for installation outdoors by sealing the bearings and completely enclosing the governing parts. Maintenance costs have been reduced by standardizing parts so that they can be used on two or more frames and by simplifying parts, such as main bearings, to reduce replacement costs.

(15) Electrode holder

The A-316 Twecotong electrode holder is a new addition to the line of insulated tong type electrode holders produced by Tweco Products Company, Wichita, Kansas. It is a smaller companion to the A-14 and A-38 holders that have been on the market for some time. Its development fills the requirements of the average job shop or maintenance welder using 200-amp welding equipment, the manufacturer states.

The A-316 features light weight, compactness, and ease of operation with a 95-lb bite on a 3/16-in. electrode. The tip and body insulation is molded laminated glass cloth bakelite using the patented "tubular-keyed" Tweco design. The insulated spring is neoprene covered. The cable connection is a simple clamp, plus socket for soldering when desired.



General specifications are: Capacity 1/16 in. through 3/16 in. electrodes; 250 amp; weight, 18 oz; length, 9 in.; palm span 2¾ in.

(16) Axial Air-Gap motor

Fairbanks, Morse and Company, Chicago, is introducing an entirely new type of electric motor designated as Axial Air-Gap—said to be the most radical departure in design since the introduction of electric motors.

Principles of the axial air-gap motor are revolutionary, according to the manufacturer. It is distinguished by the fact that the magnetic lines of force follow a path parallel to the shaft (or axis of rotation) as compared to a radial path taken by the magnetic flux in the so-called conventional motor.

"The axial air-gap motor is beyond the experimental stage," according to R. H. Morse, Jr., vice president and general sales manager of the company. He added that, "more than twenty thousand of them are now serving industry. We are now in full production, and the new motor, an exclusive Fairbanks-Morse achievement, is commercially practical today."

This new line of motors ranging in size from 1/3 to 10 hp is suitable for horizontal or vertical flange mounting, or on an angle base for belt drive.

The outstanding features are space and weight reduction, the new motor being less than half the size of the conventional type motor and weighing less by approximately 30 per cent, it is stated.

(17) Mud rate indicator

A. L. Smith, manufacturer of petroleum instruments, 4601 Montrose Boulevard, Houston, who, in recent years, has perfected the Smith well gas detector, the C-R-C holiday detector for pipe line work, well logging equipment and other technical instruments, has announced a mud circulation rate indicator.

According to the manufacturer, the instrument is designed to measure the fluctuations in rate of flow of drilling fluid as it is returned from the well. These variations in rate of flow can be correlated accurately with pressure fluctuations resulting from the penetration of gas sand, water flow, drill pipe washouts, loss of circulation, and any other factor that tends to increase or decrease the rate of fluid circulation.

The flow variations are recorded continuously and indicated mechanically and may be observed constantly by the driller on the derrick floor, as illustrated in Fig. 1. An alarm bell is also provided

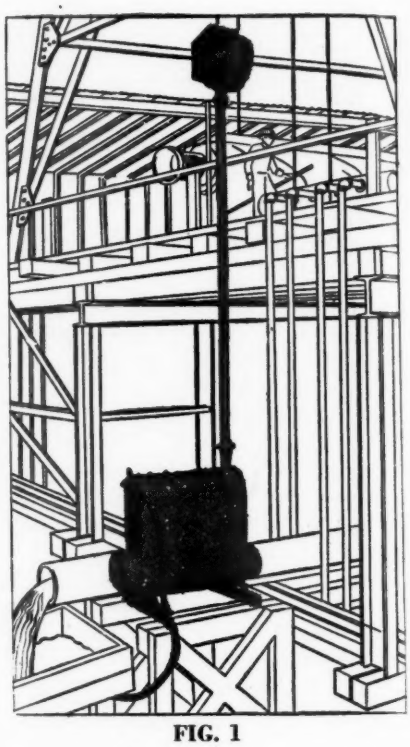


FIG. 1

to warn the driller of any unusual happening in the hole. Thus forewarned, the driller can take the necessary remedial steps to avoid a blowout, twist-off, continued loss of returns, etc.

The principle of the Smith Rate-Of-Circulation Indicator is illustrated by Fig. 2. Under a given pump pressure, drilling fluid rises to level "A" in the drilling control assembly, a point usually several inches above the flow line connection. This static head of fluid pressure

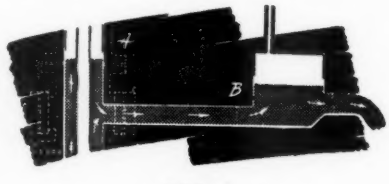


FIG. 2

controls the pressure on the flow line. Variations in the static head affect the rate of flow of fluid from the well; such variations being the result of one or more of the aforementioned factors. To detect these fluctuations in rate of flow, a small reservoir is placed in the discharge flow line and fluid level "B" is consequently established. "B" level is relative to "A" level, and any variations in levels are instantly reflected in "B," which, in turn, are calibrated and indicated on a recording instrument mounted near the driller's position for observation.

According to the manufacturer, the instrument is easy to install and operate, requiring only the changing of a chart at the end of every 24 hours of operation. The equipment is available on a monthly or annual rental basis in domestic fields or may be purchased outright for export. It is licensed and manufactured under U. S. Patent 2340993.

Drill Pipe Harmonics

Become DRILLING HARMONY

when you install
Patterson-Ballagh Casing Protectors

When we talk of harmonics in drill strings, we are speaking about vibrations from the bit or any other source which are enlarged as waves in the string at definite RPM's. These enlarged harmonic waves absorb power themselves, and also cause friction when they rub against the side of the casing or hole.

The more Patterson-Ballagh Casing Protectors installed, the shorter and less violent the vibrating waves become. When your drill string is 100% rubbered, one Protector for every joint of pipe, the effective vibrating length becomes one joint. The harmonic waves that are set up in this length due to the rotation of the drill string are not large enough to cause friction losses. With 100% protection, the pipe ceases to rub the casing or the side of the hole. Casing Protectors become the almost frictionless bearing surface. Then more power goes to the bit, the torque reading goes down, and the casing life is increased many times.

Less power loss through friction means more power saved for making hole, to say nothing of the savings in drill pipe and casing wear. Making hole economically is just like making money and that is drilling harmony in anyone's language.

Install a Patterson-Ballagh Casing Protector on every joint of your drill string and change drill pipe harmonics to drilling harmony.

Consult your Composite Catalog for sizes and details. Order from your Patterson-Ballagh man.

Specify **PATTERSON-BALLAGH**

DIVISION OF BYRON JACKSON CO

"Best Bet Yet!"

CASING PROTECTORS

Main Office:
1900 E. 65th St.
Los Angeles 1

★ 6247 Navigation Blvd.
Houston 11

★ 808 Graybar Bldg.
New York 17

★ 931 Russ Bldg.
San Francisco 4

trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(18) Drilling mud water loss control

American Cyanamid Company, 30 Rockefeller Plaza, New York 20, New York, has issued a booklet entitled "Aerotan For Drilling Mud Water Loss Control." Aerotan is a chemical reagent especially designed to treat oil-well drilling muds in order to procure better water-loss control, to improve mud wall cake characteristics, and to overcome the adverse effects of cement contamination, according to the manufacturer.

(19) PC Foamglas insulation

Pittsburgh Corning Corporation, 632 Duquesne Way, Pittsburgh 22, Pennsylvania, has issued four bulletins on uses for Foamglas insulation. They cover: (1) Foamglas insulation for tanks, towers, ducts, and breeching; (2) Foamglas core wall insulation; (3) Foamglas insulation for roofs, and (4) Foamglas insulation for floors. Foamglas is a cellular glass insulating material for industrial and commercial uses that is made by adding finely divided carbon to ground glass and subjecting the mixture to controlled high temperature heat treatment.

(20) Process centrifugal pumps

National Transit Pump and Machine Company, Oil City, Pennsylvania, has released Bulletin No. 6000, descriptive of its line of process centrifugal pumps.

(21) "Tool steel" oil-field parts

The Tool Steel Gear and Pinion Company, Cincinnati 16, Ohio, has issued bulletin No. 347, descriptive of its line of "Tool Steel" Process parts for oil-field service. Included in the equipment described are piston rods, sprockets, wash pipes, sheaves, gears and pinions, and slush pump and booster pump liners. All "Tool Steel" parts are hardened to meet the most severe oil-field requirements, according to the manufacturer. Each part is made from a low carbon steel forging, is subjected to the exclusive and special "Tool Steel" process for greatest surface hardness and depth of core, then further treated for maximum core refinement. This exclusive "Tool Steel" hardening process assures a file hard wearing surface to a depth sufficient for the life of the part, supported by a tough, ductile core, it is asserted.

(22) Ideal type "F" swivel

The National Supply Company, Toledo, Ohio, has issued a new bulletin describing its Ideal Type "F" swivel for drilling oil wells to moderate depths. The bulletin, No. 344, is illustrated with eight explosion photographs, a dimensional blueprint, and a chart showing the main bearing capacity.

(23) Bulk station pump bulletin

A new bulletin on its line of bulk station pumps has been issued by the Pump Division of Byron Jackson Company, Los Angeles California. Coded No. 46-700, the 4-page bulletin of descriptive data covers the "TLB" pump, a centrifugal type pump, which is designed to handle gasoline, butane, diesel fuels, lubricating oils, and other hydrocarbons.

(24) Flowrator instruments

A new bulletin, greatly augmented, describing Flowrator instruments for measuring flow rate of liquids and gases has recently been released by Fischer and Porter, Hatboro, Pennsylvania. This literature includes elaborate descriptions and illustrations of instruments, both assembled and disassembled. Numerous new accessories are shown, including a horizontal line adapter that makes it possible to insert Flowrator meters as easily in horizontal runs as they previously could be inserted in vertical pipes. Details of front and rear panel mounting, rear lighting arrangements, steam heating coils, and alarm devices are among the items included.

(25) The Hortonsphere

The Chicago Bridge and Iron Company, Chicago, Illinois, announces the publication of a new 8-page booklet, "The Hortonsphere." It describes the reduction of evaporation losses from highly volatile liquid by storing them under pressure in Hortonspheres. The correct storage pressure required to prevent standing losses from volatile liquids can be read directly from the chart included in this booklet. There is also a chart for determining the vapor pressure of the product to be stored at a given temperature. Gauging methods are described and photographs of three typical gauging units are shown.

(26) D + B pumps

Recently published bulletins on two lines of D+B pumps are now available through the Continental Supply Company, Dallas, Texas, D+B Challenger Pumps, bulletin 631-A, and D+B Rod Liner Pumps, bulletin 611-A, are those covered.

(27) Generator and manifold catalog

Air Reduction has announced a new 22-page, dual purpose catalog that lists and explains the complete line of Airco acetylene generators both stationary and portable. In clear, concise language it outlines the advantages of each. The stationary acetylene generators covered are the 300 lb, both single and double rated, and the 500 lb double rated. The portable acetylene generators range in size from 15 to 50 lb.

Then, after devoting a page to general information about National Carbide, the catalog goes on to Airco Manifolds both oxygen and acetylene. Oxygen manifolds covered include both the Duplex-type, designed for use with two individual banks of cylinders, and the Simplex-type accommodating a single bank of cylinders. Also described are stationary-type acetylene manifolds and Duplex-type manifolds for hydrogen and other gases.

Portable manifolds for both oxygen and acetylene are covered in detail. The oxygen portable manifold information is also applicable to other gases including carbon dioxide.

(28) "Caterpillar" progress

The evolution of Caterpillar Tractor Company, Peoria, Illinois, and its products progress achieved to date and plans for future progress, are outlined in a newly published 12-page booklet titled "Caterpillar Progress Through the Years."

Graphically illustrated, the booklet reviews the birth of heavy machinery and traces the patient strides taken to present today's efficient and productive equipment.

(29) Davey Air Chief compressors

Publication of a bulletin descriptive of the new Davey Air Chief portable compressors is announced by the Davey Compressor Company, Kent, Ohio. The new bulletin includes photos and detailed mechanical specifications of 60-105-160-210-315 cfm capacity machines.

Also included is a complete description of the new Equi-Balanced Crankshaft recently invented by Paul H. Davey, company president. This shaft employs two throws and spreads working strokes evenly over the 360 deg of crankshaft rotation.

(30) Welding fittings catalog

Tri-Clover Machine Company, Kenosha, Wisconsin, announces the publication of the new "Zephyrweld" Stainless Steel Welding Fittings Catalog. This 16-page catalog offers clear, concise data on such subjects as physical characteristics, fabrication, and adaptability of welding fittings to other fitting types; stainless steel analysis tables; bursting pressure data, and complete information covering the methods in which these new fittings are installed with light gauge commercial tolerance (OD) stainless steel tubing to provide lightweight corrosion-resistant liquid conveying lines.

(31) Oil refinery burners

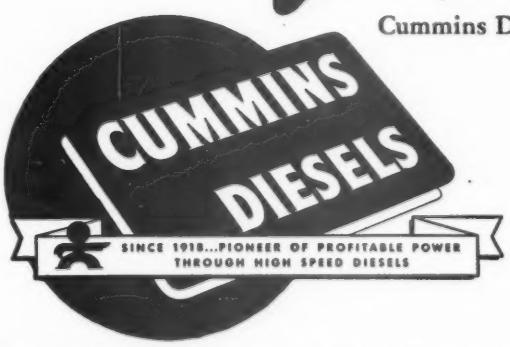
Peabody Engineering Corporation, 580 5th Avenue, New York, New York, has issued a new bulletin, No. 703, covering its Type MU oil refinery burners. This bulletin contains diagrams showing operation both of the Peabody Type M steam atomizing burner with removable gas ring and the Type T steam atomizing burner with removable gas ring. There are also photographs of the two types of steam atomizers, photographs of the popular Peabody Type MU combined gas and oil burner, and illustrations showing how the gas ring lifts right out.

Satisfaction...

. . . *derived from* a quality-built engine—exclusive product of the pioneer high-speed manufacturer.

. . . *made certain by* a complete nation-wide parts and service network.

. . . *purchased as* an intangible asset with every Cummins Dependable Diesel.



CUMMINS ENGINE COMPANY, INC. • COLUMBUS, INDIANA

PESA convention

The photographs shown on this page were taken at the recent convention of the Petroleum Equipment Suppliers' Association, held at the Mark Hopkins Hotel in San Francisco, California. The meeting was a great success. Present were representatives from many states—Texas, Oklahoma, Louisiana, Ohio, West Virginia, Missouri, New York, Pennsylvania, California. The complete story of the meeting was published in the May issue of *The Petroleum Engineer*.

Ardon B. Judd, Republic Supply Company, Houston, Texas, the new president of PESA.

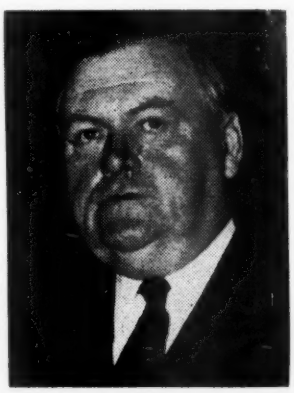
H. H. Glen, Emsco Derrick and Equipment Company, Los Angeles, the retiring president.

Left to right: A. B. Ripley, Republic Supply, Los Angeles; R. A. Schell, National Supply, Pittsburgh; R. M. Morrison, The Texas Company, New York; R. D. Hilborn, Jones & Laughlin Supply, Tulsa; John H. Lollar, Jr., Republic Supply, Houston.

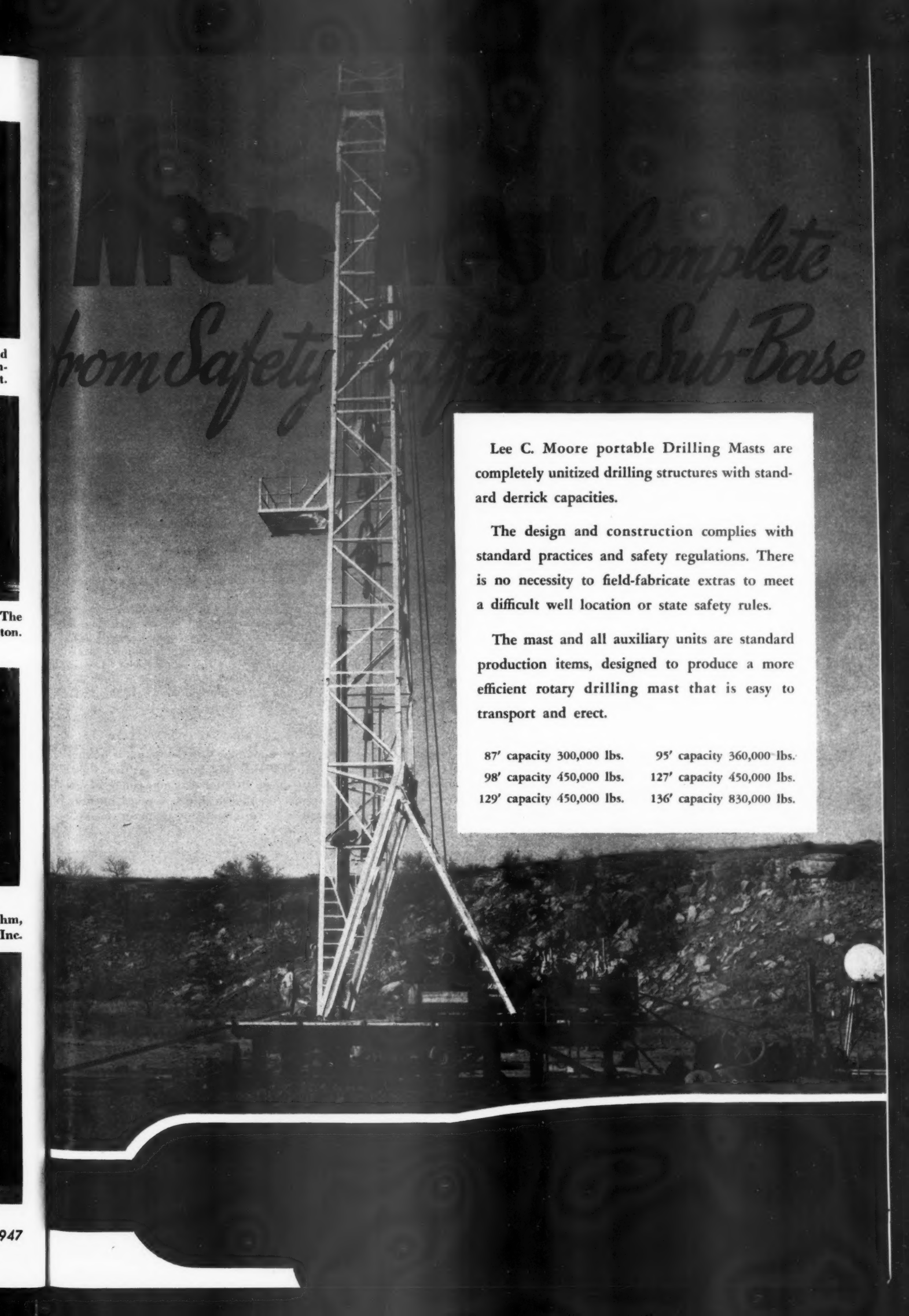
Don E. Gilman, executive vice president, Western Oil and Gas Association.

Left—A. W. McKinney, National Supply Company, Toledo, Ohio, vice president PESA.

Right — Frank Rehm, vice president, Shell Oil Company, Inc.



Left to right: A. H. Miller, Emsco Derrick and Equipment, Los Angeles; Bob Roberts, Standard of California; Frank Rehm, Shell Oil Company; Gardiner Blackman, Tide Water Associated Oil; Ted Sutter, vice president, Baker Oil Tools, Inc.



Lee C. Moore portable Drilling Masts are completely unitized drilling structures with standard derrick capacities.

The design and construction complies with standard practices and safety regulations. There is no necessity to field-fabricate extras to meet a difficult well location or state safety rules.

The mast and all auxiliary units are standard production items, designed to produce a more efficient rotary drilling mast that is easy to transport and erect.

87′ capacity 300,000 lbs.	95′ capacity 360,000 lbs.
98′ capacity 450,000 lbs.	127′ capacity 450,000 lbs.
129′ capacity 450,000 lbs.	136′ capacity 830,000 lbs.

New pipe cutter designed and built

By CLARIBEL THOMPSON, Lone Star Gas Company

A SUCCESSFUL device designed and built in the Lone Star Gas Company's transmission shops in Dallas, Texas, is a new pipe cutting tool that does an intricate pipe cutting operation up inside a gas cleaner.

EXCLUSIVE

The device is the result of an exhaustive study made by the company's gas measurement department on gas cleaners over the system. From this study it was found necessary to cut off the upper end of a 10-in. pipe that extends through a baffle plate 5 ft from the base in a number of the gas cleaners.

Without the newly designed cutting tool, which is operated through the vertical 16-in. cleanout opening at the base of the vessel, the department was faced with the problem of either cutting the shell of the cleaner apart or of installing an outside drain from the baffle plate. Either of these methods would, according to E. E. Stovall, gas measurement superintendent, have affected the safety code of the vessel in question and cost considerably more than the tool.

Stovall after considerable study of the problem, handed a rough sketch to Claude Page, general shop foreman. It was a beginning for design of the tool that could be inserted inside the vertical pipe to be cut and operated from the outside of the vessel through the opening known as the cleanout.

Page and Tom O'Dell, assistant shop foreman, pored over drawings and sketches and from Stovall's original rough drawing evolved the workable design, which was then machined and built at the shop. The new device has worked successfully on two cleaners at North Fort Worth measuring station, one at South Fort Worth, two in Waco, and one at Hollis, Oklahoma.

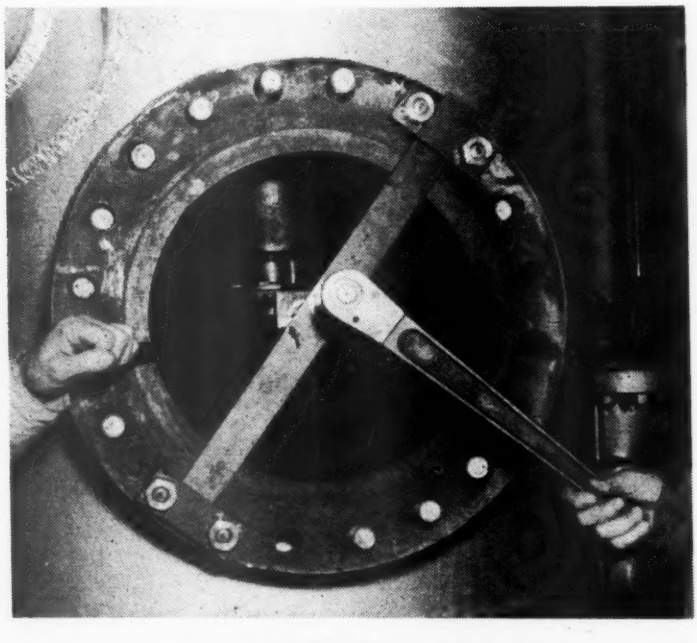
For each cleaner the operation takes approximately one hour, including assembling and installation time. The tool has a 2½ in. outside tubing for its main shaft and this is bored to fit an inside shaft 1⅝ in. in circumference. Another inner shaft, turned to 1⅝ in. with threaded sides, feeds up into the outer tubing to turn and operate the cutting tools on the head of the device.

The head consists of a 2 by 3 in. block split in two and bored in the center so that the tapering point of the inner shaft forces tension on each section of the split block where, in each of the four corners, a roller pipe cutter was installed.

A studebaker ring gear and pinion operated from outside the cleaner, drives the inner shaft in the cutting process. The gear is turned by a long ratchet wrench by hand. The pinion that operates the ring gear is held in place in the cleanout opening with a metal rod bolted to the outer rim of the cleanout and equipped with a brass center ring.

Gas cleaners involved are vessels, approximately 14 ft 9 in. tall and 4 ft in diameter and the gas supply is run through these to clean it of dirt and particles that might have been picked up along the transmission route from the field. Principal cleaning agent used is a mineral seal oil, which absorbs the dirt and drops it to the bottom of the vessel with the oil, where it can be removed.

Assembled, the cutting device weighs approximately 50 lb, is operated by Harry Chace, gas measurement shop foreman, and N. B. McKinney, special inspector for this department. The operations have been aided by pipe line men at the four points where the device has been used. ★★★



Claude Page, general shop foreman of Lone Star Gas Company, is holding pipe cutting device at left. He helped design and build the cutter. Below the implement is being bolted into place through cleanout door of gas cleaner. Next step is to turn wrench handle clockwise around opening, which causes cutting process on pipe 30 in. above this cleanout opening.

the Petroleum Engineer's CONTINUOUS TABLES

a daily reference for operating men

INSTALLMENT No. 120

A valuable and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their tenth year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have been developed as a result of suggestions for new tables, direct contributions and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue; 113-115, inclusive, in the January, 1947, issue; 116-118, inclusive, in the April, 1947, issue.

INDEX TO TABLES

		Index No.	Page	Issue
Methods of calculating bottom-hole pressures in gas wells	(sheet 1)	P 509.1	189	June
Methods of calculating bottom-hole pressures in gas wells	(sheet 2)	P 509.1	191	June
Gas lift design, installation, and operation	(sheet 7)	P 515.	231	May
Gas lift design, installation, and operation	(sheet 8)	P 515.	233	May
Method of calculating gas flow at critical velocity		P 621.01	243	May
Alignment chart for blending and dilution calculations		P 746.	235	May
Ignition and knock characteristics of hydrocarbon fuels	(sheet 7)	P 765.	193	June
Ignition and knock characteristics of hydrocarbon fuels	(sheet 8)	P 765.	195	June
Ignition and knock characteristics of hydrocarbon fuels	(sheet 9)	P 765.	197	June
Evaluation of absorber operating efficiency	(sheet 6)	P 773.	237	May
Evaluation of absorber operating efficiency	(sheet 7)	P 773.	239	May
Evaluation of absorber operating efficiency	(sheet 8)	P 773.	241	May
Evaluation of absorber operating efficiency	(sheet 9)	P 773.	199	June
Evaluation of absorber operating efficiency	(sheet 10)	P 773.	201	June

INDEX TO ADVERTISERS IN TABLES

		Page	Issue	Backing Table No.
Engineers & Fabricators	(sheet 7)	194	June	P 765.
Foxboro Co.	(sheet 10)	202	June	P 773.
Griscom-Russell Co.	(sheet 9)	198	June	P 765.
National Radiator Co.	(sheet 8)	196	June	P 765.
Petroleum Electric Power Association	(sheet 9)	200	June	P 773.
Toledo Pipe Threading Machine Co.	(sheet 1)	190	June	P 509.1
Waldrip Engineering Co.	(sheet 2)	192	June	P 509.1

Tested by Time Proved by Performance

More than 140,000,000 feet of Republic *Electric Weld* Casing and Tubing has given unexcelled performance under all conditions

Here's a casing that asks no favors. It takes tough jobs in stride. It speeds make-up and running of strings. It can ease your mind of pull-out and collapse worries.

Republic Electric Weld Casing stabs, spins-in and tongs-up *fast.* Threads are clean and accurate—and every length is straight.

Made from flat-rolled steel, its wall thickness is uniform—providing plenty of metal at every point under the threads. Cold formed and electric welded by Republic's *improved* process, it is uniformly round and uniformly strong in wall and weld. Full normalizing insures uniform structure. And cold sizing further increases its high yield strength.

Claims? Yes, but claims backed up by the indisputable records of more than 140,000,000 field-proved feet of Republic Electric Weld Casing and Tubing . . . the same records that are backing your judgment every time you order these tubular products.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

INSPECTED INSIDE AND OUT

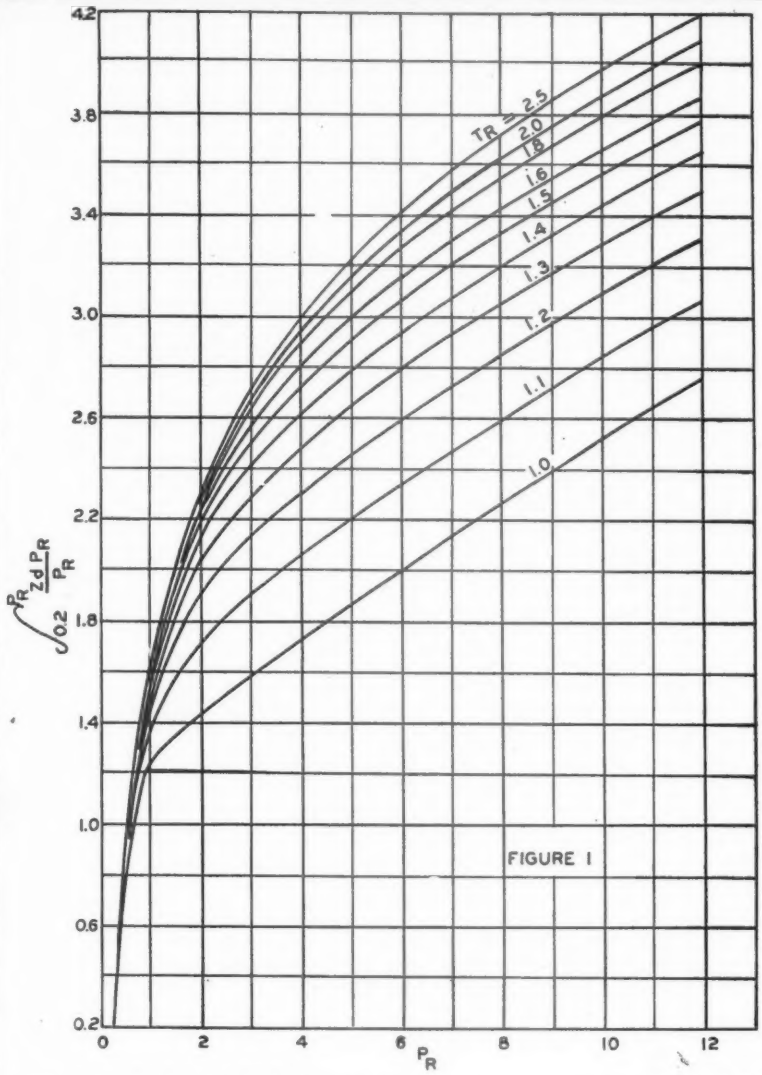
Republic Electric Weld Casing and Tubing are made from flat-rolled steel, both sides of which are inspected. Thus, the surface which becomes the inside wall is free from hidden defects.

REPUBLIC *Electric Weld* NORMALIZED CASING AND TUBING

REPUBLIC STEEL REG. U.S. PAT. OFF.

Other Republic Products include Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

METHODS OF CALCULATING BOTTOM-HOLE PRESSURES IN GAS WELLS



Three methods of calculating bottom-hole pressure are discussed and compared by Rzasa and Katz[5] with an actual bottom-hole pressure measured in a gas well[2]. All three methods require a trial and error solution.

A method involving a direct solution and obviating the trial-error solution for calculating bottom-hole pressure is presented in this article. The accuracy of this method is comparable to the two shorter methods given in the article by Rzasa and Katz[5].

● **Derivation of equation.** In a column of fluid of uniform composition, the following differential equation can be applied to the change in pressure, dP, over a height of fluid, dh, having density, ρ:

$$dP = \rho dh \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Using compressibility factors, the density, ρ, can be expressed as:

$$\rho = \frac{MP}{ZRT} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where:

ρ = density, lb per cu ft,

M = molecular weight of fluid,

P = pressure, psf,

R = 1544 psfa, cu ft per lb mole, °R,

T = absolute temperature, °F + 460, and

Z = compressibility factor.

Substituting equation (2) into equation (1):

$$dP = \frac{MPdh}{ZRT} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Rearranging and integrating equation (3):

$$\int_{P_1}^{P_2} \frac{ZTdP}{P} = \frac{(h_2 - h_1)\,M}{R} \quad . \quad . \quad (4)$$

$(h_2 - h_1)$ represents the length of fluid between pressures P_2 and P_1.

For simplification, $(h_2 - h_1)$ will be replaced with h representing the height or depth of fluid in the well.

Removing the temperature, T, from the integral by replacing it with the proper average temperature T_a, equation (4) becomes:

$$\int_{P_1}^{P_2} \frac{ZdP}{P} = \frac{hM}{RT_a} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Equation (5) can be graphically integrated by using compressibility charts. As compressibility charts are customarily placed on a general basis of reduced temperature and pressure, there is no reason why the above integration cannot be carried through on the same general basis.

By definition:

$$P_r = \frac{P}{P_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Where:

P_r = reduced pressure,

P_c = critical pressure of fluid (abs), and

P = pressure of fluid (abs).

From equation (6):

$$dP = P_c dP_r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Substituting equations (6) and (7) into equation (5):

$$\int_{P_{r,1}}^{P_{r,2}} \frac{ZdP_r}{P_r} = \frac{hM}{RT_a} \quad . \quad . \quad . \quad . \quad (8)$$

Integration of equation (8) has been completed graphically, using compressibility factors for methane published by Brown[1]. This integration has been carried out between pressure limits of P_r = 0.2 and P_r extending to a value of 12 for constant reduced temperatures between 1.0 and 2.5. The results are shown in Fig. 1. The choice of the lower pressure limit P_r = 0.2 was purely arbitrary and any other value might have been chosen. The integral used is between limits so that absolute values from zero pressure are not necessary.

Although a rigorous solution indicates that the arithmetic average of wellhead and bottom-hole temperatures is not strictly the proper average, the error introduced by this type of average is generally small. The temperature gradients of shut-in gas wells have been reported in the literature. The gradients are essentially linear after a depth of 2000 ft has been exceeded. Temperature gradients vary with different fields. Two typical gradients are presented in Fig. 2. One is taken from the article of French[3] for the Wasco field, California, and the other is from the article of Eilerts and Schellhardt[2] for a well in the East Texas field.

Literature cited.

1. Brown, *The Petroleum Engineer, 11*, No. 4, 21 (1940).
2. Eilerts and Schellhardt, *U. S. Bureau of Mines, R. I.* 3402 (1938).
3. French, *Oil and Gas Journal, 37*, No. 50, 43 (1939).
4. Katz, *Ref. and Nat. Gasoline Mfr., 21*, No. 6, 58 (1942).
5. Rzasa and Katz, *A.I.M.E. Transactions, 160* 113 (1945).
6. Standing and Katz, *A.I.M.E. Transactions 146*, 140 (1942).

NOTE: Nomenclature is shown on Sheet 2, P 509.1. Taken from the article "Calculations of Bottom-Hole Pressures," by Frank C. Fowler in *The Petroleum Engineer*, March, 1947, pages 88 to 91, inclusive.

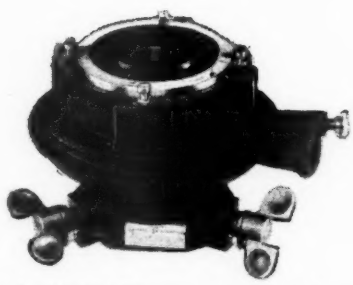
. . . at the time of the FIRST TOLEDO pipe tools

This is the 1903 Ford — the first of a long line of production cars which Henry Ford built. It was in 1903 that he organized the Ford Motor Company. Previously, as chief engineer of the Detroit Automobile Company, he had produced several outstanding racing cars.

The recent death of Henry Ford marked the passing of one of the great leaders in motor car progress.

★ ★ ★

It was in those early days of "horseless carriages"—45 years ago—that TOLEDO Pipe Tools were first being produced. In their field . . . they, too, became leaders. Demand for these easy-threading, dependable Pipe Tools has grown steadily through the years. The line of four basic threaders introduced in 1902 has expanded to the wide range of TOLEDO-Engineered Pipe Tools and equipment of today. The Toledo Pipe Threading Machine Company, Toledo, Ohio. New York Office, No. 2 Rector Street Bldg.



Toledo SIMPACT—an example of outstanding design and performance! A self-contained, adjustable threader for 1" to 2" pipe. Sizes changed instantly with one set high speed steel dies. Accurate, dependable.

"TOLEDO"

TOLEDO PRECISION PIPE TOOLS

METHODS OF CALCULATING BOTTOM-HOLE PRESSURES IN GAS WELLS

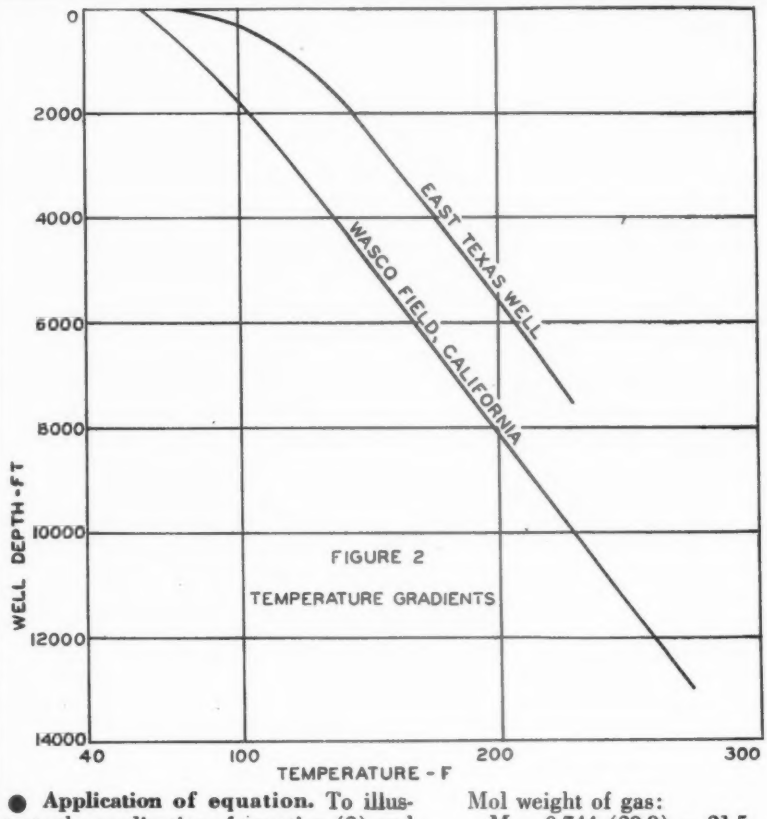


FIGURE 2
TEMPERATURE GRADIENTS

● **Application of equation.** To illustrate the application of equation (8) and Fig. 1 to an actual calculation of the bottom-hole pressure, well data from an article by Eilerts and Schellhardt[2] are used. The well depth is 7500 ft with a shut-in temperature gradient shown in Fig. 2 as the East Texas well. The specific gravity of the gas is 0.744 (referred to air) and its composition such that the pseudo-critical temperature and pressure were 386 F and 664 psia, respectively. Pressure at the wellhead is 2600 psia.

● **Solution:** The method of determining the average temperature in the well will affect the calculated pressure. Rzasa and Katz[5] used the arithmetic average of the wellhead and bottom-hole temperatures. This average temperature equals:

$$\frac{76+228}{2} = 152 \text{ F}$$

Referring to Fig. 2, it can be seen that the true average temperature is higher than 152 F. This true average can be obtained by calculating the area between the curve and the ordinate of well depth and dividing it by the depth of the well. Since the abscissa begins at 40 F in Fig. 2, care must be exercised so that the area between 0 F and 40 F is not omitted. The average well temperature calculated in this manner is 168 F. To emphasize the importance of obtaining reliable temperature gradients, the bottom-hole pressure is determined for both average temperatures.

Mol weight of gas:

$$M = 0.744\ (28.9) = 21.5$$

$$P_{r,1} = \frac{2600}{664} = 3.92$$

Using average temperature of 152 F:

$$T_r = \frac{152+460}{386} = 1.59$$

From equation (8):

$$\int_{P_{r,1}}^{P_{r,2}} \frac{ZdP_r}{P_r} = \frac{21.5\ (7500)}{1544\ (612)} = 0.171$$

Interpolation between $T_r = 1.5$ and $T_r = 1.6$ for $T_r = 1.59$ in Fig. 1 gives:

$$\int_{0.2}^{3.92} \frac{ZdP_r}{P_r} = 2.78$$

Therefore:

$$\int_{0.2}^{P_{r,2}} \frac{ZdP_r}{P_r} = 2.78 + 0.171 = 2.95$$

From Fig. 1:

$$\int_{0.2}^{P_{r,2}} \frac{ZdP_r}{P_r} = 2.95 \text{ at } P_{r,2} = 4.82$$

Thus the bottom-hole pressure = 4.82 (664) = 3200 psia.

This value of 3200 psia for the bottom-hole pressure compares favorably with the experimental measured value of 3192 psia and is as accurate as the two shorter methods of Rzasa and Katz[5].

Using an average temperature of 168 F, a value of 4.76 is obtained for $P_{r,2}$. This gives a bottom-hole pressure of 3160 psi. Normally one would expect this value to be closer to the measured pressure than the value calculated with the arithmetic average temperature of 152 F. Before a definite conclusion can be made regarding the type of average temperature to be used in equation (8), additional comparisons between calculated and carefully measured pressures should be made. Pressure measurements must be made after the well is shut-in for a period sufficient to establish reliable measurements. A second shut-in test on the well reported by Eilerts and Schellhardt[2] shows a wellhead pressure of 2580 psi and a bottom pressure of 3139 psi.

Although $\int_{P_1}^{P_2} \frac{ZdP}{P}$ has been determined specifically for calculating pressures in gas wells, it may prove useful in other types of problems. One example occurs in determining the horsepower for isothermal compression. The theoretical work required by a compressor is equal to the $\int_{P_1}^{P_2} VdP$. If the compression is isothermal, the $\int_{P_1}^{P_2} VdP$ is equal to $\frac{RT}{M}\int_{P_1}^{P_2} \frac{ZdP}{P}$. This integral can be determined from the differences between the values of the integral at the suction and discharge pressures read from Fig. 1.

● **Conclusions.** Equation (8), when used in conjunction with Fig. 1, will yield a direct solution to bottom-hole pressure computations that have an accuracy comparable to trial-error methods[5].

For best results, the well information necessary for such calculations includes wellhead pressure, well depth, temperature gradient of well, and gas composition. If gas composition is not known, the gravity can be used to obtain the pseudo-critical temperature and pressure[4,6].

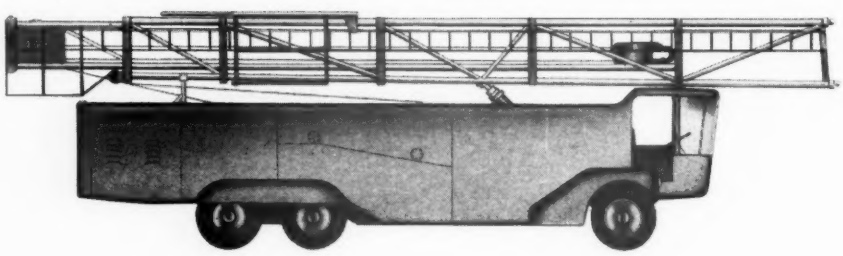
Nomenclature.

- h = well depth, ft,
- M = molecular weight of gas,
- P = pressure, psfa,
- P_c = critical pressure of gas, psfa,
- P_r = reduced pressure, $\frac{P}{P_c}$,
- R = gas constant, 1544 psfa, cu ft per lb mole, °R,
- T = temperature, °R = °F + 460,
- T_a = average temperature in well bore, °R = °F + 460,
- T_c = critical temperature of gas, °R = °F + 460,
- T_r = reduced temperature, $\frac{T}{T_c}$,
- V = volume of gas at temperature, T, and pressure, P,
- Z = compressibility factor for gas at temperature, T, and pressure, P, and
- ρ = density of gas, lb per cu ft.

NOTE: References are shown on Sheet 1, P 509.1. Taken from the article "Calculations of Bottom-Hole Pressures," by Frank C. Fowler in *The Petroleum Engineer*, March, 1947, pages 88 to 91, inclusive.

Nose first

• **THE WALDRIP "321" ASSURES FASTER SPOTTING AT WELL LOCATION because it is the ONLY self-propelled servicing and drilling rig that drives into the well location NOSE FIRST.**



CHECK THESE OUTSTANDING FEATURES—Better balance with less weight • Less load over front wheels • Clear operating vision • Easily accessible motor in rear • Unit completely guarded by smooth, streamlined contour guards • Furnished with gas, gasoline, butane or Diesel engine • Furnished with torque converter or gear box • Equipped with 65', 60,000 pound or 90,000 pound hook load capacity Waldrip telescoping derrick.

WRITE FOR DETAILS

WALDRIP
ENGINEERING COMPANY
MAIN OFFICE AND PLANT: 11810 CENTER STREET, HOLLYDALE, CALIFORNIA
San Joaquin Valley Division: 30th and M Sts., Bakersfield, Calif.

IGNITION AND KNOCK CHARACTERISTICS OF HYDROCARBON FUELS

TABLE 5. Calculated octane numbers of the paraffin hydrocarbons.

Paraffin hydrocarbons CnH2n+2	Blending octane no. Calc.	Obs.
n-Pentane	55	60
n-Hexane	32	29
n-Heptane	2	0
n-Octane	−18	−19
n-Nonane	−84	−84
n-Decane	−47	—
n-Undecane	−56	—
n-Dodecane	−64	—
2-Methyl butane	90	92
2-Methyl pentane	72	69
3-Methyl pentane	84	84
2-Methyl hexane	54	55
3-Methyl hexane	63	65
2-Methyl heptane	29	—
3-Methyl heptane	39	—
4-Methyl heptane	59	—
2-Methyl octane	0	—
3-Methyl octane	8	—
4-Methyl octane	26	—
2-Methyl nonane	−21	—
3-Methyl nonane	−16	—
4-Methyl nonane	− 7	—
5-Methyl nonane	24	—
2-Methyl decane	−37	—
3-Methyl decane	−34	—
4-Methyl decane	−29	—
5-Methyl decane	−15	—
2-Methyl undecane	−48	—
3-Methyl undecane	−46	—
4-Methyl undecane	−43	—
5-Methyl undecane	−37	—
6-Methyl undecane	−13	—
2,2-Dimethyl propane	144	116
2,2-Dimethyl butane	100	101
2,3-Dimethyl butane	108	124
2,2-Dimethyl pentane	79	80
2,3-Dimethyl pentane	96	94
2,4-Dimethyl pentane	84	80
3,3-Dimethyl pentane	96	98
2,2-Dimethyl hexane	62	—
3,3-Dimethyl hexane	73	—
2,3-Dimethyl hexane	73	—
2,4-Dimethyl hexane	73	—
2,5-Dimethyl hexane	67	—
3,4-Dimethyl hexane	79	—
2,3-Dimethyl heptane	54	—
2,4-Dimethyl heptane	68	—
2,5-Dimethyl heptane	54	—
2,6-Dimethyl heptane	47	36
3,4-Dimethyl heptane	72	—
3,5-Dimethyl heptane	59	—
2,2-Dimethyl heptane	39	—
3,3-Dimethyl heptane	52	—
4,4-Dimethyl heptane	70	—
2,3-Dimethyl octane	28	—
2,4-Dimethyl octane	42	—
2,5-Dimethyl octane	42	—
2,6-Dimethyl octane	28	—
2,7-Dimethyl octane	19	25
3,4-Dimethyl octane	46	—
3,5-Dimethyl octane	46	—
3,6-Dimethyl octane	35	—
4,5-Dimethyl octane	56	—
2,2-Dimethyl octane	11	—
3,3-Dimethyl octane	24	—
4,4-Dimethyl octane	46	—
2,3-Dimethyl nonane	− 2	—
2,4-Dimethyl nonane	8	—
2,5-Dimethyl nonane	38	—
2,6-Dimethyl nonane	8	—
2,7-Dimethyl nonane	− 2	—
2,8-Dimethyl nonane	− 7	—
3,4-Dimethyl nonane	14	—
3,5-Dimethyl nonane	40	—
3,6-Dimethyl nonane	14	—
3,7-Dimethyl nonane	4	—
4,5-Dimethyl nonane	48	—
4,6-Dimethyl nonane	25	—
2,2-Dimethyl nonane	−18	—
3,3-Dimethyl nonane	− 6	—
4,4-Dimethyl nonane	10	—
5,5-Dimethyl nonane	49	—
2,3-Dimethyl decane	−23	—
2,4-Dimethyl decane	− 7	—
2,5-Dimethyl decane	5	—
2,6-Dimethyl decane	5	—
2,7-Dimethyl decane	− 7	—
2,8-Dimethyl decane	−23	—
2,9-Dimethyl decane	−27	—
3,4-Dimethyl decane	−14	—
3,5-Dimethyl decane	0	—
3,6-Dimethyl decane	0	—
3,7-Dimethyl decane	−14	—
3,8-Dimethyl decane	−20	—
4,5-Dimethyl decane	6	—
4,6-Dimethyl decane	6	—
4,7-Dimethyl decane	− 9	—
5,6-Dimethyl decane	22	—
2,2-Dimethyl decane	−31	—
3,3-Dimethyl decane	−26	—
4,4-Dimethyl decane	−17	—
5,5-Dimethyl decane	3	—
2,2,3-Trimethyl butane	119	116
2,2,4-Trimethyl pentane	90	100
2,2,3-Trimethyl pentane	102	105
2,3,3-Trimethyl pentane	108	—
2,2,3-Trimethyl hexane	79	—
2,2,4-Trimethyl hexane	79	—
2,2,5-Trimethyl hexane	73	—
2,3,3-Trimethyl hexane	81	—
3,3,4-Trimethyl hexane	86	—
2,4,4-Trimethyl hexane	81	—
2,3,4-Trimethyl hexane	87	—
2,3,5-Trimethyl hexane	82	—
2,2,3-Trimethyl heptane	60	—
2,2,4-Trimethyl heptane	72	—
2,2,5-Trimethyl heptane	60	—
2,2,6-Trimethyl heptane	55	—
2,3,4-Trimethyl heptane	79	—
2,3,5-Trimethyl heptane	68	—
2,3,6-Trimethyl heptane	64	—
2,4,5-Trimethyl heptane	79	—
2,4,6-Trimethyl heptane	76	—
2,3,3-Trimethyl heptane	63	—
2,4,4-Trimethyl heptane	79	—
2,5,5-Trimethyl heptane	63	—
3,3,4-Trimethyl heptane	78	—
3,3,5-Trimethyl heptane	67	—
3,4,4-Trimethyl heptane	82	—
3,4,5-Trimethyl heptane	82	—
3,5,5-Trimethyl heptane	67	—
2,2,3-Trimethyl octane	37	—
2,2,4-Trimethyl octane	48	—
2,2,5-Trimethyl octane	48	—
2,2,6-Trimethyl octane	37	—
2,2,7-Trimethyl octane	31	—
2,3,4-Trimethyl octane	57	—
2,3,5-Trimethyl octane	57	—
2,3,6-Trimethyl octane	47	—
2,3,7-Trimethyl octane	43	—
2,4,5-Trimethyl octane	64	—
2,4,6-Trimethyl octane	57	—
2,4,7-Trimethyl octane	53	—
2,5,6-Trimethyl octane	57	—
2,3,3-Trimethyl octane	41	—
2,4,4-Trimethyl octane	56	—
2,5,5-Trimethyl octane	56	—
2,6,6-Trimethyl octane	41	—
3,3,4-Trimethyl octane	55	—
3,3,5-Trimethyl octane	55	—
3,3,6-Trimethyl octane	45	—
3,4,5-Trimethyl octane	66	—
3,4,6-Trimethyl octane	60	—
3,4,4-Trimethyl octane	59	—
3,5,5-Trimethyl octane	59	—
4,4,5-Trimethyl octane	66	—
2,2,3-Trimethyl nonane	1	—
2,2,4-Trimethyl nonane	11	—
2,2,5-Trimethyl nonane	40	—
2,2,6-Trimethyl nonane	11	—
2,2,7-Trimethyl nonane	1	—
2,2,8-Trimethyl nonane	− 4	—
2,3,4-Trimethyl nonane	30	—
2,3,5-Trimethyl nonane	50	—
2,3,6-Trimethyl nonane	30	—
2,3,7-Trimethyl nonane	19	—
2,3,8-Trimethyl nonane	14	—
2,4,5-Trimethyl nonane	56	—
2,4,6-Trimethyl nonane	38	—
2,4,7-Trimethyl nonane	30	—
2,4,8-Trimethyl nonane	24	—
2,5,6-Trimethyl nonane	56	—
2,5,7-Trimethyl nonane	50	—
2,5,8-Trimethyl nonane	48	—
2,6,7-Trimethyl nonane	30	—
2,3,3-Trimethyl nonane	10	—
2,4,4-Trimethyl nonane	27	—
2,5,5-Trimethyl nonane	57	—
2,6,6-Trimethyl nonane	27	—
2,7,7-Trimethyl nonane	10	—
3,3,4-Trimethyl nonane	26	—
3,3,5-Trimethyl nonane	48	—
3,3,6-Trimethyl nonane	26	—
3,3,7-Trimethyl nonane	16	—
3,4,5-Trimethyl nonane	58	—
3,4,6-Trimethyl nonane	41	—
3,4,7-Trimethyl nonane	34	—
3,5,6-Trimethyl nonane	58	—
3,5,7-Trimethyl nonane	53	—
3,4,4-Trimethyl nonane	31	—
3,5,5-Trimethyl nonane	45	—
3,6,6-Trimethyl nonane	31	—
4,4,5-Trimethyl nonane	57	—
4,4,6-Trimethyl nonane	39	—
4,5,6-Trimethyl nonane	62	—
4,5,5-Trimethyl nonane	63	—
2,2,3,3-Tetramethyl butane	130	130
2,2,3,3-Tetramethyl pentane	115	—
2,2,4,4-Tetramethyl pentane	96	—
2,2,3,4-Tetramethyl pentane	114	—
2,3,3,4-Tetramethyl pentane	121	—
2,2,3,3-Tetramethyl hexane	85	—
2,2,4,4-Tetramethyl hexane	85	—
2,2,5,5-Tetramethyl hexane	78	—
2,2,3,4-Tetramethyl hexane	92	—
2,2,3,5-Tetramethyl hexane	86	—
2,2,4,5-Tetramethyl hexane	86	—
2,3,3,4-Tetramethyl hexane	95	—
2,3,3,5-Tetramethyl hexane	89	—
2,3,4,4-Tetramethyl hexane	95	—
3,3,4,4-Tetramethyl hexane	94	—
2,2,3,3-Tetramethyl heptane	67	—
2,2,4,4-Tetramethyl heptane	82	—
2,2,5,5-Tetramethyl heptane	67	—
2,2,6,6-Tetramethyl heptane	60	—
2,2,3,4-Tetramethyl heptane	82	—
2,2,3,5-Tetramethyl heptane	72	—
2,2,3,6-Tetramethyl heptane	69	—
2,2,4,5-Tetramethyl heptane	82	—
2,2,4,6-Tetramethyl heptane	79	—
2,2,5,6-Tetramethyl heptane	69	—
2,3,3,4-Tetramethyl heptane	83	—
2,3,3,5-Tetramethyl heptane	74	—
2,3,3,6-Tetramethyl heptane	71	—
2,4,4,5-Tetramethyl heptane	88	—
2,4,4,6-Tetramethyl heptane	85	—
2,5,5,6-Tetramethyl heptane	71	—
2,3,4,4-Tetramethyl heptane	88	—
2,3,5,5-Tetramethyl heptane	74	—
2,3,4,5-Tetramethyl heptane	87	—
2,3,4,5-Tetramethyl heptane	84	—
2,3,5,6-Tetramethyl heptane	76	—
2,4,5,5-Tetramethyl heptane	83	—
3,3,4,4-Tetramethyl heptane	88	—
3,3,5,5-Tetramethyl heptane	73	—
3,3,4,5-Tetramethyl heptane	86	—
3,4,4,5-Tetramethyl heptane	91	—
4,4,5,5-Tetramethyl heptane	87	—
2,2,3,3-Tetramethyl octane	46	—
2,2,4,4-Tetramethyl octane	60	—
2,2,5,5-Tetramethyl octane	60	—
2,2,6,6-Tetramethyl octane	46	—
2,2,7,7-Tetramethyl octane	39	—
2,2,3,4-Tetramethyl octane	61	—
2,2,3,5-Tetramethyl octane	61	—
2,2,3,6-Tetramethyl octane	53	—
2,2,3,7-Tetramethyl octane	49	—
2,2,4,5-Tetramethyl octane	67	—
2,2,4,6-Tetramethyl octane	61	—
2,2,4,7-Tetramethyl octane	58	—
2,2,5,6-Tetramethyl octane	61	—
2,2,5,7-Tetramethyl octane	58	—
2,2,6,7-Tetramethyl octane	49	—
2,3,3,4-Tetramethyl octane	63	—
2,3,3,5-Tetramethyl octane	63	—
2,3,3,6-Tetramethyl octane	55	—
2,3,3,7-Tetramethyl octane	52	—
2,4,4,5-Tetramethyl octane	71	—
2,4,4,6-Tetramethyl octane	66	—
2,4,4,7-Tetramethyl octane	63	—
2,5,5,6-Tetramethyl octane	66	—
2,3,4,4-Tetramethyl octane	66	—
2,3,5,5-Tetramethyl octane	66	—
2,3,6,6-Tetramethyl octane	55	—
2,3,4,5-Tetramethyl octane	72	—
2,3,4,6-Tetramethyl octane	67	—
2,3,4,7-Tetramethyl octane	64	—
2,3,5,6-Tetramethyl octane	67	—
2,3,5,7-Tetramethyl octane	64	—
2,4,5,5-Tetramethyl octane	71	—
2,4,6,6-Tetramethyl octane	63	—
2,5,6,6-Tetramethyl octane	63	—
3,3,4,4-Tetramethyl octane	64	—
3,3,5,5-Tetramethyl octane	64	—
3,3,6,6-Tetramethyl octane	53	—
3,3,4,5-Tetramethyl octane	71	—
3,3,4,6-Tetramethyl octane	66	—
3,3,5,6-Tetramethyl octane	66	—
3,4,5,5-Tetramethyl octane	73	—
3,4,5,6-Tetramethyl octane	74	—
4,4,5,5-Tetramethyl octane	72	—

—Taken from the article "Chemical Structure Affects Knocking," by Peter J. Gaylor in the March, 1947, issue of *The Petroleum Engineer*, pages 72 to 76, inclusive.

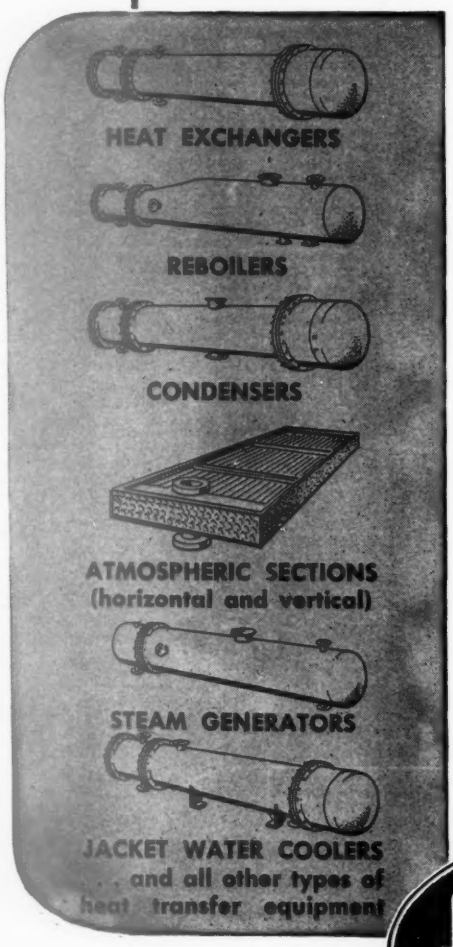
Delivery Date?

PRICE?

Guaranteed Performance?

COMPLETE RELIABILITY?

. . . this hidden factor is most important when considering bids for HEAT TRANSFER EQUIPMENT



Unless the bid under your consideration is from a completely reliable concern, it means nothing.

If you can't depend on the delivery date—if satisfactory performance is questionable, price means nothing.

EFCO has established an outstanding reputation for complete reliability.

EFCO delivery dates can be depended on — completely.

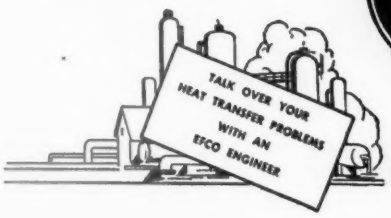
Performance is so uniformly good that guarantees can be forgotten.

Long life is inherent in EFCO equipment.

This reputation results from good engineers, good workmen, good plant equipment, expert management, and a meticulousness in every phase of every job that is seldom parallelled.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395
Houston 8, Texas

EFCO



HEAT TRANSFER EQUIPMENT

IGNITION AND KNOCK CHARACTERISTICS OF HYDROCARBON FUELS

TABLE 6. Calculated octane numbers of the n-olefine hydrocarbons.

n-Olefine hydrocarbons C_nH_{2n}	Blending octane numbers Calc.	Obs
1-Butene	96	111.5
2-Butene	138	—
1-Pentene	97	98.5
2-Pentene	132	125
1-Hexene	78	80
2-Hexene	93	100
3-Hexene	110	—
1-Heptene	61	59.5
2-Heptene	80	—
3-Heptene	95	95
1-Octene	41	38.5
2-Octene	54	55
3-Octene	69	73
4-Octene	83	91
1-Nonene	12	15
2-Nonene	29	—
3-Nonene	45	—
4-Nonene	73	—
1-Decene	−12	—
2-Decene	− 1	—
3-Decene	14	—
4-Decene	44	—
5-Decene	64	—
1-Undecene	−29	—
2-Undecene	−23	—
3-Undecene	−13	—
4-Undecene	5	—
5-Undecene	53	—
1-Dodecene	−43	—
2-Dodecene	−38	—
3-Dodecene	−32	—
4-Dodecene	−21	—
5-Dodecene	6	—
6-Dodecene	41	—

TABLE 7

Hydrocarbon	Dimensions D	D′	D″	Stability factor	Octane numbers (Nash's) Blending value Calc.	Obs.	(Doss') Clear Res.	M. M.
n-Pentane	9.08	3.45	3.18	0.133	55	60	61.7	61.9
n-Hexane	10.34	3.45	3.18	0.103	32	29	24.8	26
n-Octane	12.85	3.45	3.18	0.0664	−18	−19	..	−17
n-Nonane	14.11	3.45	3.18	0.0551	−34	−34	..	−45
2-Methyl butane	7.83	4.04	4.02	0.265	90	92	92.3	90.3
2-Methyl pentane	9.08	3.90	3.81	0.180	72	69	..	73
3-Methyl pentane	9.08	4.34	4.44	0.234	84	84	..	75
2,2-Dimethyl propane	6.57	4.34	5.70	0.573	144	116	..	83
2,2-Dimethyl butane	7.83	4.04	4.86	0.320	100	101	91.8	93.4
2,3-Dimethyl butane	7.83	4.63	4.86	0.367	108	124	0.32	94.3
2,2-Dimethyl pentane	9.08	3.90	4.44	0.210	79	80	..	93
2,3-Dimethyl pentane	9.08	4.79	5.17	0.300	96	94	88.5	83
2,4-Dimethyl pentane	9.08	4.35	4.44	0.234	84	80	..	82
3,3-Dimethyl pentane	9.08	4.34	5.70	0.300	96	98	..	84
2,2-Dimethyl hexane	10.34	3.81	4.19	0.149	62	..	72.5	77.4
3,3-Dimethyl hexane	10.34	4.04	4.86	0.184	73	..	75.5	83.4
2,3-Dimethyl hexane	10.34	4.40	4.52	0.186	73	..	71.3	78.9
2,4-Dimethyl hexane	10.34	4.40	4.52	0.186	73	..	65.2	69.9
2,5-Dimethyl hexane	10.34	4.17	4.18	0.163	67	..	55.5	55.7
3,4-Dimethyl hexane	10.34	4.63	4.86	0.210	79	..	76.3	81.7
3,4-Dimethyl heptane	11.60	4.79	5.07	0.180	72	..	..	56
2,6-Dimethyl heptane	11.60	4.79	5.07	0.180	72	..	..	31
2,2,3-Trimethyl butane	7.83	4.63	5.70	0.430	119	116	1.83	0.07
2,2,4-Trimethyl pentane	9.08	4.35	5.07	0.267	90	100	100	100
2,2,3-Trimethyl pentane	9.08	4.79	5.70	0.331	102	105	1.18	99.9
2,3,3-Trimethyl pentane	9.08	4.79	6.33	0.368	108	..	0.61	100
2,2,3-Trimethyl hexane	10.34	4.40	5.03	0.207	79	..	..	90
2,3,3-Trimethyl hexane	10.34	4.40	5.36	0.221	81	..	..	..
2,3,4-Trimethyl hexane	10.34	4.99	5.36	0.250	82	..	..	..
2,2,6-Trimethyl heptane	11.60	4.05	4.44	0.134	55	..	..	..
2,4,5-Trimethyl heptane	11.60	5.09	5.49	0.208	79	..	..	..
2,4,4-Trimethyl heptane	11.60	4.64	6.12	0.211	79	..	..	..
2,5,5-Trimethyl heptane	11.60	4.20	4.86	0.152	63	..	..	..
1-Butene	6.57	4.30	4.02	0.300	96	111.5	..	80
2-Butene	6.57	5.23	4.44	0.538	138	..	..	83
1-Pentene	7.83	4.39	4.24	0.304	97	98.5	92	..
2-Pentene	7.83	5.84	5.30	0.505	132	125	98	80
1-Hexene	9.08	4.20	4.03	0.250	78	80	80	..
2-Hexene	9.08	5.04	4.59	0.281	93	100	89	78
3-Hexene	9.08	5.84	5.30	0.375	110	..	97	..
2,2,3,3-Tetramethyl butane	7.83	4.63	6.54	0.494	130	130	130	103
1-Heptene				0.0789—0.0879			54	
3-Octene				0.139—0.172			72.5	
2-me-5-hexene				0.219—0.250			82	
2,4-Dime 2-pentene				0.586—0.738			>100	
2,3-Dime 2-pentene				0.594—0.745			127 bbl	
2-me-2-butene				0.691—0.887			98	

It is a well known fact that compactness of a molecule is a fairly good measure of knocking properties—the more compact the molecule, the lower is the knocking tendency, and, conversely, the higher is the octane number. No good single numerical value has been advanced in this country, however, for evaluating the property of compactness in the case of fuels. A search of the literature has revealed some work done by Kobayasi[1] that seems to provide a measure for the purpose.

If we take the n-pentane molecule, as illustrated in Fig. 23, we find that it can be designated as having three dimensions, its length (D), its height (D′), and its width (D″). Kobayasi has taken the various instabilities of the molecule in the three directions to be α, β, and γ, and has evaluated them numerically as follows:

$$\alpha : \beta : \gamma = D/D : D'/D : D''/D = 1 : D'/D : D''/D$$

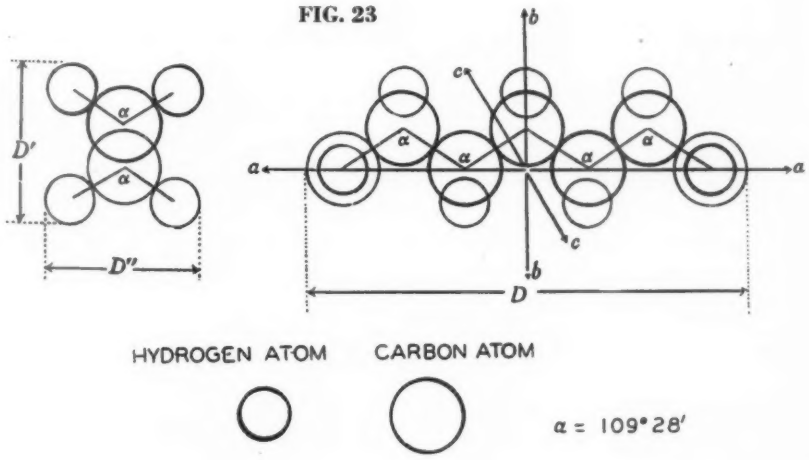
The products $\alpha\beta\gamma$, which he calls the "unstability" factor, or which we can call the ***stability index***, can be designated as:

$$\alpha\beta\gamma = D'/D \cdot D''/D = D'D''/D^2$$

In reality, this dynamic stability factor indicates the closeness to which the molecule approaches a sphere while rotating (the factor for which would be 1, for the dimensions are the same in all directions), and hence determines the stability of the molecule toward thermal disintegration or attack by oxygen molecules or atoms. Various physical properties, such as melting point, boiling point, etc., have been correlated with this factor[2]

Kobayasi has indicated that this stability index ($\alpha\beta\gamma$) is related to clear blending octane numbers of paraffin and olefin hydrocarbons, and Tables 5 and 6 show some of his predicted knock data, whereas Table 7 lists some dimensional data.

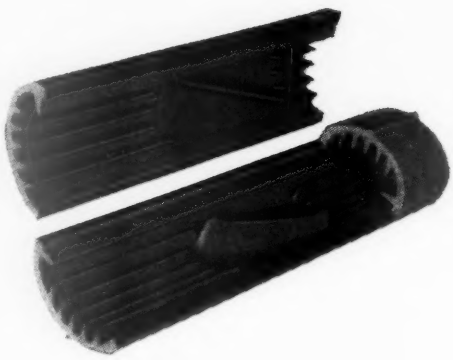
FIG. 23

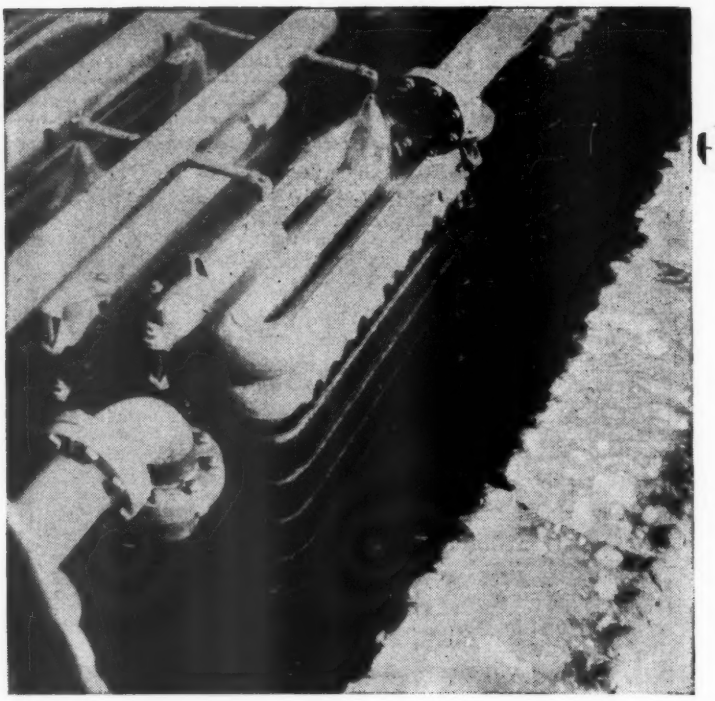


NOTE: See Sheet 9 for footnotes and references. Taken from the article "Chemical Structure Affects Knocking," by Peter J. Gaylor in the March, 1947, issue of *The Petroleum Engineer*, pages 72 to 76, inclusive.

CONCENTRATED

SULPHURIC ACID COOLERS





Typical installation of National Cast Iron Cooling Sections in Sulphuric Acid Cooling service.

Tough, corrosion resistant National CAST IRON Cooling Sections are specified by most producers of sulphuric acid.

The cooling of concentrated sulphuric acid is one of many Cooling and Condensing Services which can best be performed by National CAST IRON Sections. They are regularly specified for such jobs as condensers for gasoline, naphtha, tar vapor and solvents, and as coolers for wash oils, ammonia liquors, caustic soda and petroleum products.

NATIONAL field engineers will consult with you at any time on your condensing and cooling problems, and without obligation. WRITE FOR CATALOG CP-16.

INDUSTRIAL DIVISION

The National Radiator Company

221 CENTRAL AVENUE . . . JOHNSTOWN, PENNSYLVANIA

IGNITION AND KNOCK CHARACTERISTICS OF HYDROCARBON FUELS

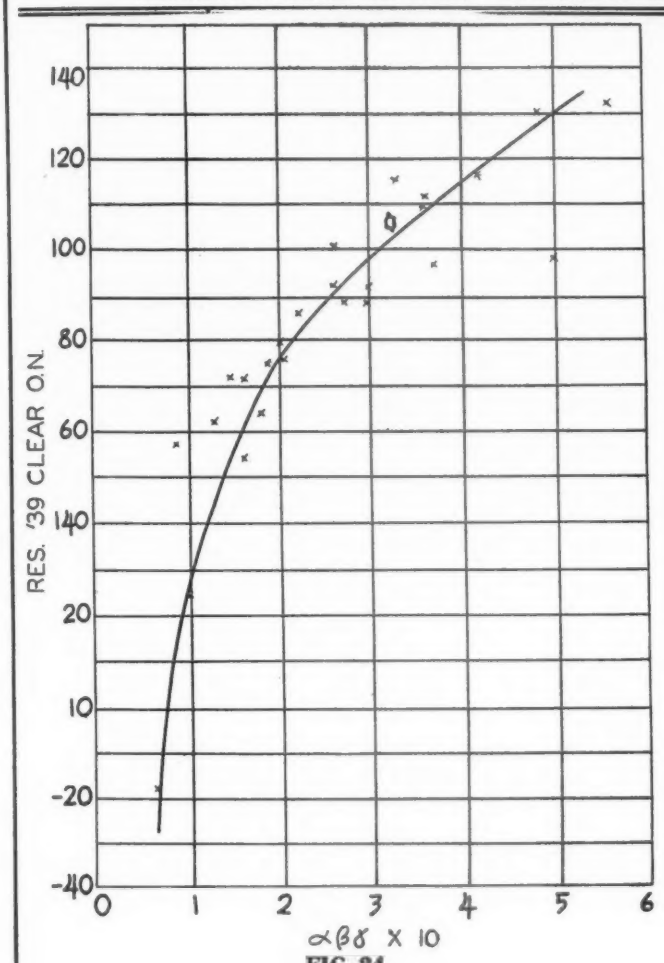


FIG. 24

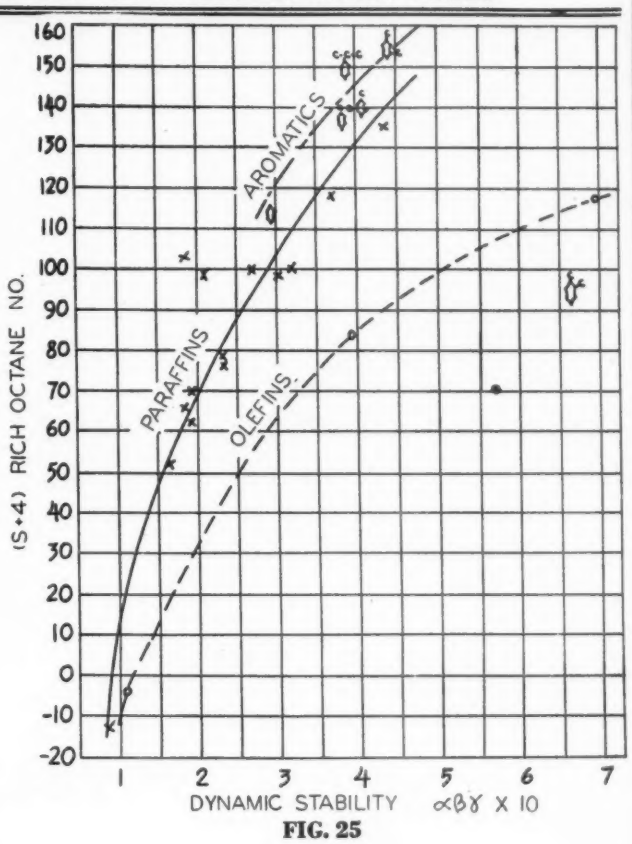


FIG. 25

The Research '39 clear octane numbers of various pure hydrocarbons listed in Doss, Third Edition, have been plotted in Fig. 24 against Kobayasi's calculated values for $\alpha\beta\gamma$, and although a few discrepancies are noted in the high octane range, there is support for his observations, which were based on much older data.

Furthermore, if we take (S + 4) rich, supercharged blending values obtained for various pure hydrocarbons, we can plot them as in Fig. 25, where separate curves are obtained for aromatics, paraffins, and olefins, the different positions of the curves apparently being due to varying lead susceptibilities, for these are heavily leaded blends, in contrast to the clear fuels shown in Fig. 24.

It will also be observed that the leaded (supercharged, rich) blend curves are similar in nature to the curve for clear fuels (Fig. 24), the equation for which has been calculated to be:

$$O.N. = 294.7\ (10\alpha\beta\gamma)^{0.167} - 257$$

Several years ago, Mibashan[3] described an empirical relationship between octane number and "centralization" index, which is related to chemical structure. Fig. 26 shows how Kobayasi's stability index compares with this centralization index for a number of paraffins and olefins. There appears to be a definite correlation.

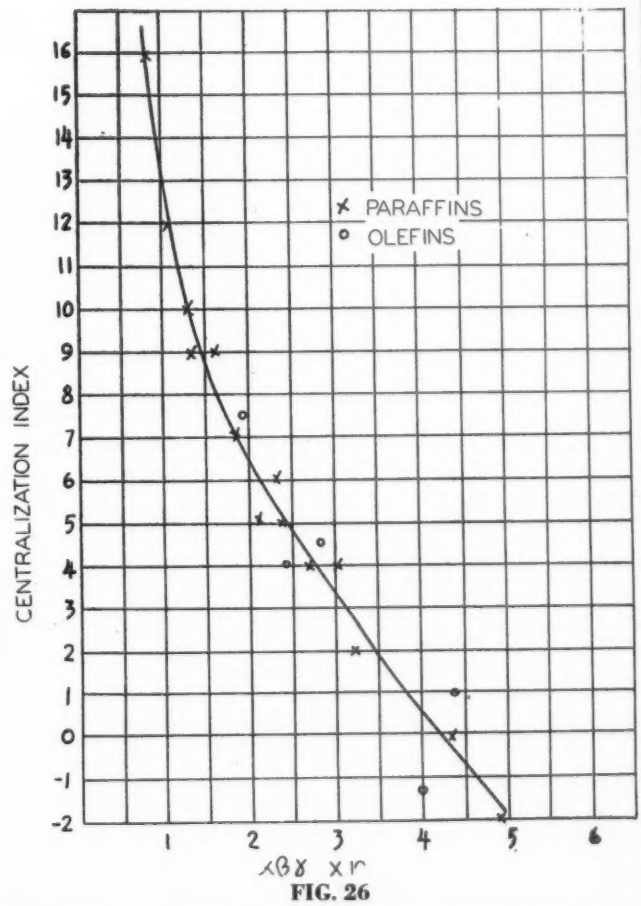
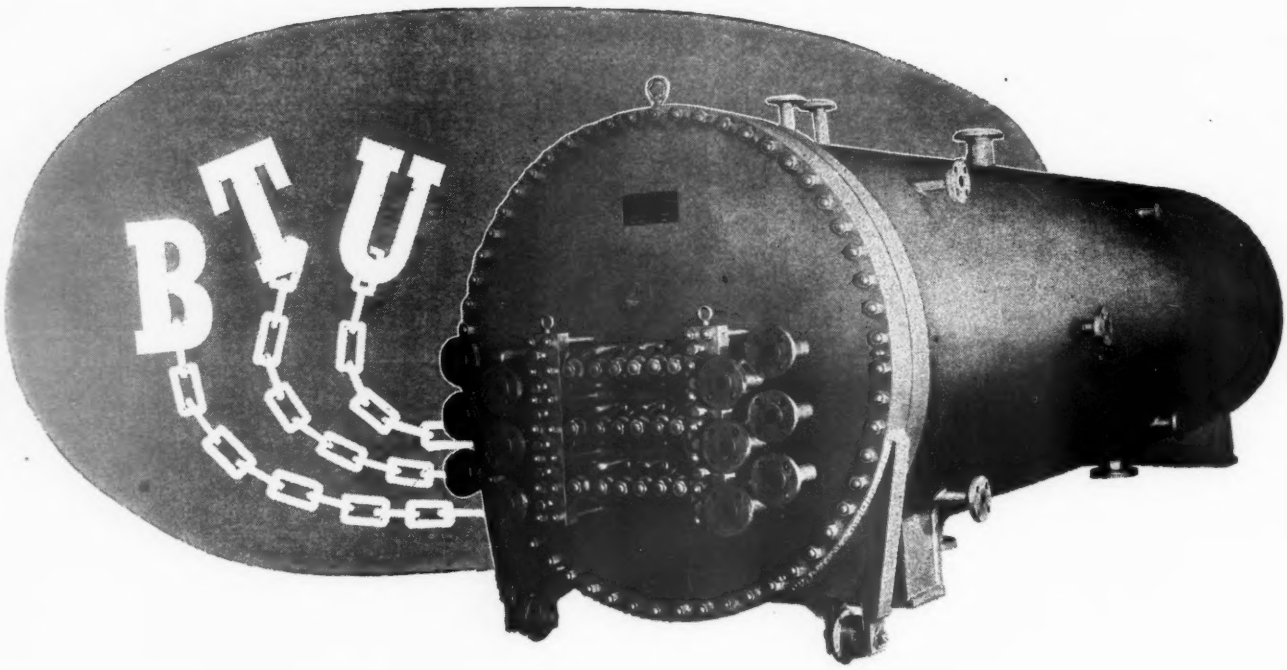


FIG. 26

References.

1. Kobayasi, *J. Soc. Chem. Ind.* (Japan) April, 1937 (Supplement), p. 153B, June, 1937, p. 219B, September, 1937, p. 317B.
2. Ibid. October, 1937, p. 341B.
3. *Refiner*, July 1943, p. 80.

—Taken from the article "Chemical Structure Affects Knocking," by Peter J. Gaylor in the March, 1947, issue of *The Petroleum Engineer*, pages 72 to 76, inclusive.



Capture Waste Heat *with a*
G-R STEAM GENERATOR

In many refineries, cracking coil tar, hot gas oil, or lighter oils are being cooled with water, resulting in waste of heat.

In other instances, hot gases are being discharged to atmosphere or their heat is not being utilized.

Much of this heat can be recovered by using the hot material, liquid or gas to generate steam at boiler pressures from raw, untreated water in a G-R Steam Generator. And this G-R method of heat recovery has additional important benefits . . . it lightens the load on the cooling system, reduces pumping costs, and provides an economical method of securing additional steam capacity.

G-R Steam Generators are available in a variety of types, either with submerged heating elements or with heater type design. Write for full information on these heat-saving units that may effect important economies in your plant.

REG. U.S. PAT. OFF.

THE GRISCOM-RUSSELL CO.
285 Madison Avenue — New York 17, N. Y.

GR-132

GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

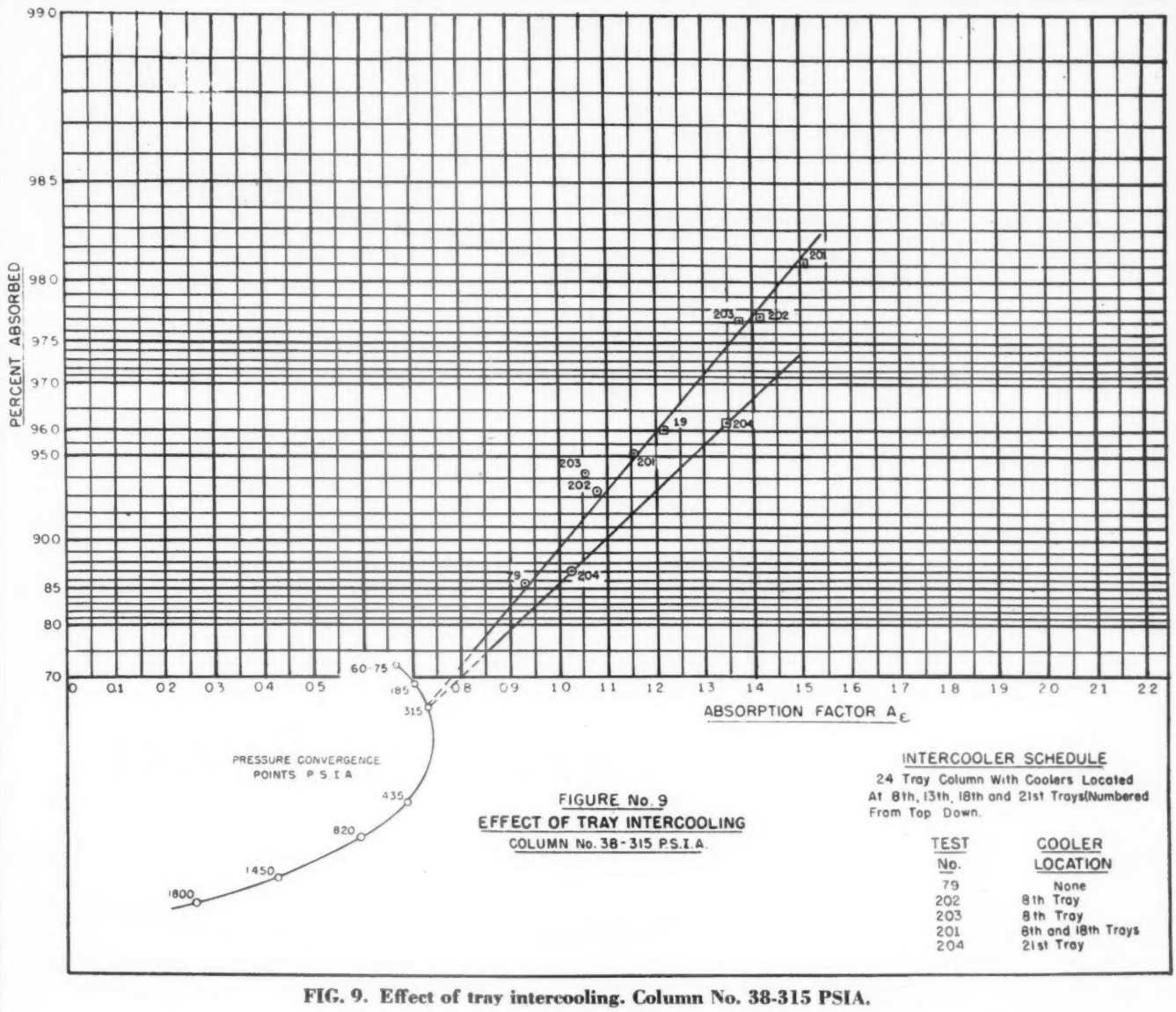


FIGURE No. 9
EFFECT OF TRAY INTERCOOLING
COLUMN No. 38-315 P.S.I.A.

FIG. 9. Effect of tray intercooling. Column No. 38-315 PSIA.

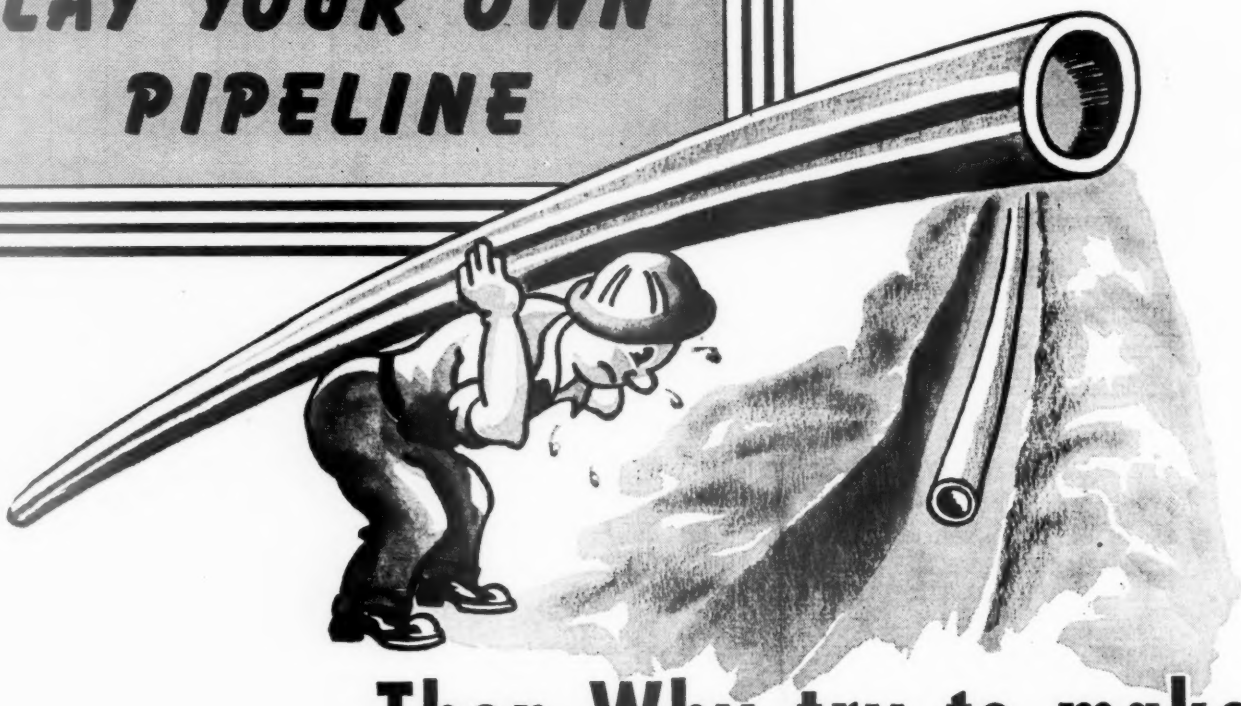
Fig. 9 reveals the effectiveness with which the straight line chart handles the intercooled absorber operation. For this particular test series the lean oil and rich gas rates were held substantially constant, and the number and location of active oil coolers were changed. As shown on the chart, this control resulted in a single operating line for those four tests which utilized coolers in the top 75 per cent of the column. For the fifth test (No. 204) wherein cooling was employed near the bottom of the column, a second, less efficient, operating line is indicated. Here again the straight line chart reflects a well understood absorption law, namely, that the most effective cooling is that applied to the upper section of a column.

We have previously indicated that a column's relative effectiveness is measured by the slope of its operating line. The reason for this, of course, resides in the factors composing A_ϵ—which for small changes in column control, make A_ϵ substantially proportional to the lean oil circulation rate. Under the circumstances, the steeper the operating line the smaller the value of A_ϵ, and the smaller the quantity of lean oil required for a given key component recovery. Consequently, the column that exhibits the steepest slope for a given operating pressure is the most effective, and when several columns containing the same number of trays are concerned, the most efficient.

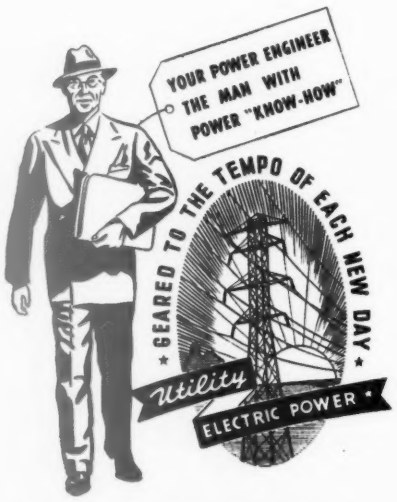
When this efficiency relationship is coupled with the fact that all operating lines for all columns can be drawn as straight lines passing through unique pressure focal points, it is seen that only one additional operating point need be located to identify completely a column's effectiveness (or efficiency). If this additional point is then located on a conveniently chosen "per cent recovery" reference line, the column's effectiveness at any given pressure can be accurately identified by a single "efficiency rating" number, i.e., by the value of A_ϵ for that particular reference per cent recovery. In our work we have chosen 95 per cent for this reference base.

—Taken from the article by E. G. Ragatz and J. A. Richardson in the January, 1947, issue of *The Petroleum Engineer*, pages 110 to 118, inclusive.

YOU WOULDN'T LAY YOUR OWN PIPELINE



Then Why try to make your own Power



For proof . . . contact the Power Engineer of your local Utility Electric Power Company. He is at your service . . . without cost or obligation.

Use Low-Cost *Utility Electric Power!*

Laying pipelines is a tough job that requires special skill, trained personnel and Tailor-Made equipment. That's why pipe line contractors, specialists at this type of work, can do a better job.

For the *best* in Power, look to Utility Electric Power. It's dependable, efficient, and adaptable to any Power Job in the Oil Industry. The Utility Electric Power Companies are specialists in power and not only offer you the best . . . but the most economical power.

Use Utility Electric Power!

PETROLEUM ELECTRIC POWER ASSOCIATION

Box 1498, Oklahoma City, Oklahoma

EVALUATION OF ABSORBER OPERATING EFFICIENCY

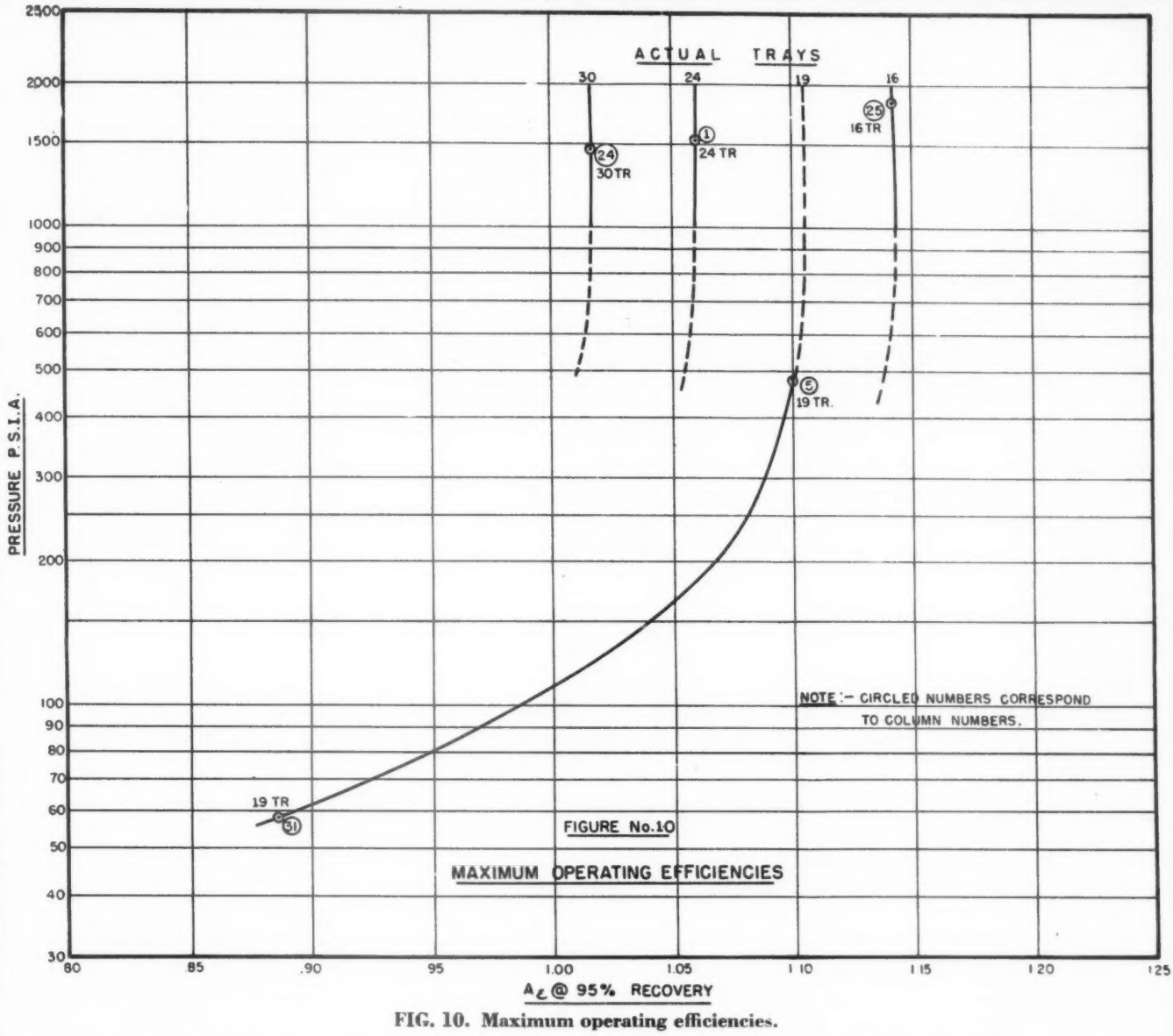


FIG. 10. Maximum operating efficiencies.

On Fig. 10 we have plotted values of A_e at 95 per cent recovery against the log of the absolute operating pressure for the most efficient columns studied to date—with the number of trays utilized in each column being noted, and lines of fixed tray number being drawn through them. If sufficient high efficiency data were available, such a chart would clearly specify the complete range of operation of the industry's most efficient units. In our case, however, it merely indicates what may be accomplished in the future.

Our meager results are presented for what they are worth. Although we have no means of knowing whether or not the subject columns were operating at approximately the same relative efficiency, it is interesting to note that a rough pattern is established that exhibits the proper relationship between A_e requirements and number of trays employed. Although crude, it is certainly a first step in the right direction, namely, to make it possible for the plant operator quickly and accurately to determine whether or not his own plant equipment is "up to the industry's best standard," and if not, in what degree it departs from that standard.

To us, the most outstanding feature of this first attempt at an overall industry column comparison was that out of some 40 columns analyzed, only five units fully qualified for inclusion in the maximum efficiency grid, with two or three others presenting some evidence that with more complete testing they also might have made the grade.

In other words, only 50 per cent at the very outside of all columns studied were operating at efficiencies approximating the industry's best indicated standard at the time of testing, which fact is certainly a challenge to both the operator and the designing engineer.

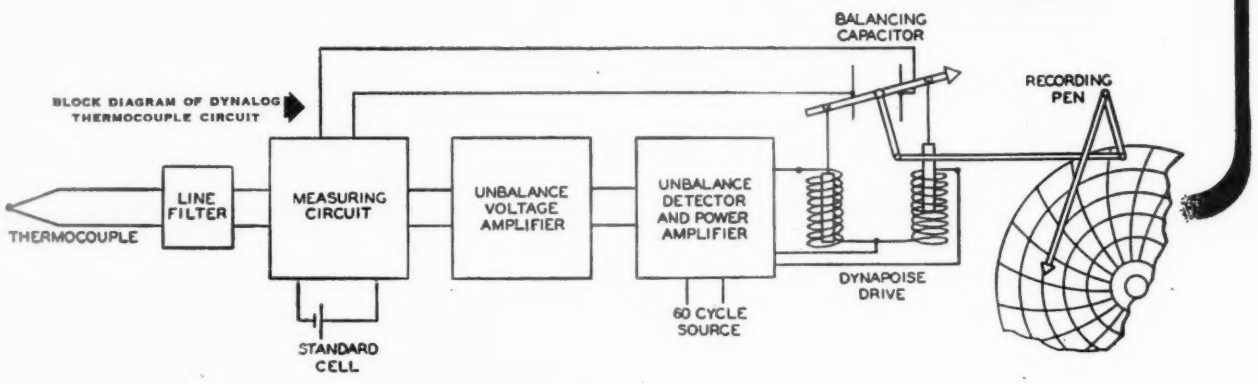
In meeting this challenge, an accurate and consistent measure of column performance is the first essential. For this service we offer a new process tool, "The Straight Line Chart," confident that it will live up to its initial promise of consistently evaluating the absorber performace throughout its operating range.

Literature cited.

1. Souders Mott, Jr., and Brown, G. G., *Ind. Eng. Chem.*, 24, 519 (1932).
2. Kremser, A., *Proc. Calif. Natural Gasoline Assoc.*, 5, No. 2 (1930).
3. Edmister, *W. C., Ind. Eng. Chem.*, 35, 837 (1943).
4. Horton, George, and Franklin, W. B., *Ind. Eng. Chem.*, 32 (1940).

—Taken from the article by E. G. Ragatz and J. A. Richardson in the January, 1947, issue of *The Petroleum Engineer*, pages 110 to 118, inclusive.

NEW DYNALOG CONTROLLER for THERMOCOUPLES



Practically Eliminates Maintenance!

EMPLOYING THE FIRST wholly-electronic design ever developed for industrial thermocouple instruments, Foxboro's DYNALOG Controller offers a combination of speed, accuracy and sensitivity never before available in controllers.

What's more, the simplicity of DYNALOG design practically eliminates maintenance. Here's why:

NO SLIDEWIRE—Complete slidewire mechanism is replaced by simple balancing capacitor.

NO MOVING CONTACTS—Slidewire contact is eliminated by positive-connected capacitor.

NO GEARS—Only simple direct linkage.

NO ROTARY MOTORS—Balancing drive motor is simple push-pull magnetic type. No brushes, commutator or bearings.

NO GALVANOMETER—Not affected by vibration.

NO BATTERIES—No standardizing. Measured voltage is compared directly to standard cell.

NO SERVICING—except simple replacements of standard widely-used type vacuum tubes.

Write for Bulletin 397 containing full details of DYNALOG Controllers in air-operated (Model 40) and electric (Rotax) types. **The Foxboro Co., 130 Neponset Avenue, Foxboro, Mass., U. S. A.**

FOXBORO REG. U. S. PAT. OFF. **ELECTRONIC INSTRUMENTS**

running tour with men in the industry

● **Dr. Claude C. Peavy** has been named chief engineer of Houdry Process Corporation. Dr. Peavy joined the Houdry organization a little more than a year ago as chief of the process design division, after many years experience in all phases of petroleum refining engineering, including catalytic cracking. He joined Houdry from Socony-Vacuum Oil Company's refinery engineering division where he was chief process engineer. Prior to his five years of service with Socony-Vacuum he had been an engineer for E. B. Badger and Sons Company for nine years.

Dr. C. C. Peavy

Harmon J. Monnik has been made chief of the mechanical engineering department of Houdry, it also is announced. **William C. Dickerman** will be in charge of process design.

Development engineering will continue to be carried on at the Houdry Laboratories near Marcus Hook, Pennsylvania, under the direction of **Raymond C. Lassiat.**

● **Howard R. Brooks,** chief oil scout for Magnolia Petroleum Company, was elected president of the National Oil Scouts and Landmen's Association at the 1947 convention in New Orleans. He succeeds **S. S. Stinson** who becomes a member of the executive board.

● **Alfonso Martinez Gil,** an industrial engineer from Madrid, Spain, visited Dallas, Texas, recently as a representative of the Spanish Oil Company, CAMPSA. He is spending a year in the United States to familiarize himself with drilling and exploration practices in this country.

A. M. Gil

Federico Steegmann, another industrial engineer with CAMPSA, is also visiting in this country. Both of these men have been granted a fellowship for studies in this country by the Delamo Foundation in California. They have visited several oil fields in Pennsylvania, Oklahoma, and Texas, and are planning to study prospecting methods in California this summer through the courtesy of The Texas Company. They wish to express their appreciation of the courtesies extended to them by the American oil and supply companies.

● **Dr. Paul H. Carnell** has resigned his position in the research department of Phillips Petroleum Company, Bartlesville, Oklahoma. He is now in charge of research and development at Leonard Refineries, Inc., Alma, Michigan.

● **Charles F. Bonnet** has been appointed assistant to Arthur J. Campbell, general sales manager, Industrial Chemicals Division, American Cyanamid Company, New York City. Bonnet will continue as manager of the petroleum chemicals department, and H. E. Nehms will be acting department head.

● **David C. Peterson,** former industrial consultant, has been appointed director of engineering and research at the main Chicago plant of Stewart-Warner Corporation. Before joining Stewart-Warner, Peterson was actively engaged for six years as an industrial consultant to several large diesel engine manufacturers, working on various phases of engineering and production. During the war he also served as a consultant for the Army Air Forces.

● **L. H. Major** is the new manager of Freedom-Valvoline Oil Company's pipe line division, Beaver, Pennsylvania. His appointment has just been announced by B. L. Heath, vice president in charge of manufacturing. For the last ten years Major was superintendent of the company's Freedom Refinery. He joined Freedom - Valvoline after his graduation from Penn State College as a petroleum engineer. His entire business career has been devoted to the petroleum industry. In his new assignment he will fill the office left vacant by the passing of J. J. Dunlevy.

L. H. Major

● **G. A. Tompson,** vice president, and **R. G. Ayers,** general manager of sales, of the Bethlehem Supply Company, recently returned to Tulsa from a trip to the West Coast where they attended the annual meeting of the Petroleum Equipment Suppliers' Association at San Francisco. They extended their trip to include a visit with the Bethlehem Supply Company of California in Los Angeles and to call on the trade.

● **F. Q. Wilson** has been appointed Cincinnati district manager for Elliott Company, Jeannette, Pennsylvania. Wilson, an electrical engineer graduate of Kansas University, joined the Elliott Company in 1938. He was sent as a field engineer to the Kansas City office in 1940, then to the Tulsa office in 1942, where he became Tulsa manager in 1945.

● **Clyde Simpson** recently became a member of the Thomas P. Pike Drilling Company in the capacity of vice president. Simpson is a graduate of Stanford University. His experience in the oil business began prior to 1930. Since 1935 he has been with Bell and Loffland, drilling contractors, later Loffland Brothers, with which company he was assistant to A. S. (Doc) Hayes, vice president and general manager. He left his position with Loffland Brothers in March, 1947.

● **Harry W. Griffith,** who has been an engineer in the research laboratory at the Ambridge, Pennsylvania, plant of The National Supply Company, has been appointed field engineer for the company's Spang-Chalfant Division and will have his headquarters in Caracas, Venezuela. Griffith, a graduate in mechanical engineering of the University of Pittsburgh, has been with the tubular division of the company since 1937.

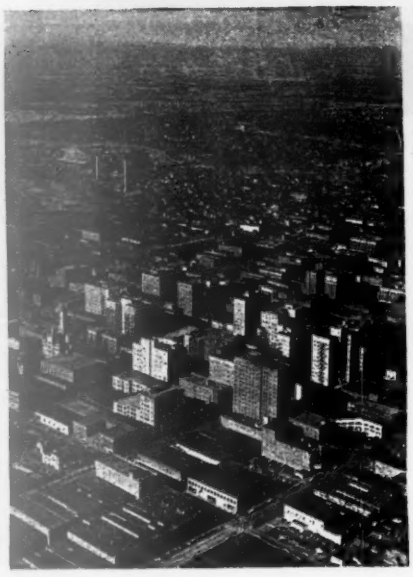
Harry W. Griffith

● **R. W. Kerr,** formerly vice president and treasurer of the Plomb Tool Company, Los Angeles, was made executive vice president at the last meeting of the board of directors. **H. C. Baumgartner,** formerly secretary and comptroller, was made secretary and treasurer. Other officerships confirmed at the meeting include: **M. M. Mautner,** vice president in charge of industrial relations; **C. W. Coslow,** vice president in charge of manufacturing; **F. G. Robbins,** vice president in charge of research and development, and **J. P. Danielson,** vice president in charge of the J. P. Danielson Division.

● **Francis E. Powell, Jr.,** has been appointed chairman of the foreign trade committee of the Socony-Vacuum Oil Company, Inc., and **F. H. Henry** has been named vice chairman, it has been announced by **Walter L. Faust,** vice president and director in charge of foreign trade.

Arthur G. Reed and **O. J. Bellis** have been made members of the foreign trade committee.

L. A. Blumenthal and **M. J. A. Bertin** are appointed to the newly created positions of assistant to the general manager of foreign trade. **C. V. Barry** will become European representative of the foreign trade committee's planning staff with headquarters in London, **Charles F. Darlington** becomes American representative, and **C. T. Crawford** will be manager of the supply operations.



10 MORE
LAYNE UNITS
FOR WICHITA, KAN.

Wichita — magic city of progress — cross roads of the western airlines — growing and prospering has just ordered ten more complete Layne high efficiency Well Water Units. This makes a total of thirty-five, with a daily production capacity of 45 million gallons of water. Here again, quality, sturdiness, and overall efficiency of Layne Well Water Systems have scored definite superiority.

Wichita long endured a dangerously low water supply, but Layne top flight hydrological engineering skill explored and found water bearing strata — and then installed modern water producing equipment.

Wichita is only one of many cities that profited by placing its water producing problem up to Layne—the world's most experienced ground water developers. Such proven skill is worthy of serious consideration by all cities, factories, railroads, refineries and irrigation projects that need more water.

Unusually interesting and valuable bulletins, catalogs, etc., may be obtained by writing Layne & Bowler, Inc., General Offices, Memphis 8, Tennessee.

PUMPS for Wells—Lakes—Rivers—Reservoirs — Irrigation Projects — are obtainable in sizes from 40 to 16,000 gallons per minute, powered by electric motor, V-belt or angle gear drives. Write for Pump Catalog.

LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. * Layne-Atlantic Co., Norfolk, Va. * Layne-Central Co., Memphis, Tenn. * Layne-Northern Co., Mishawaka, Ind. * Layne-Louisiana Co., Lake Charles, La. * Louisiana Well Co., Monroe, La. * Layne-New York Co., New York City * Layne-Northwest Co., Milwaukee, Wis. * Layne-Ohio Co., Columbus, Ohio * Layne-Pacific, Inc., Seattle, Wash. * Layne-Texas Co., Houston, Texas * Layne-Western Co., Kansas City, Mo. * Layne-Western Co. of Minn., Minneapolis, Minn. * International Water Supply Ltd., London, Ont., Can. * Layne-Hispano Americana, S. A., Mexico, D. F.

● **W. A. Eardley** has been appointed chief petroleum engineer in the producing department of Standard of California. He succeeds **E. G. Gaylord,** who recently was elected a vice president and director of California Research Corporation.

W. A. Eardley

A graduate of Stanford University, Eardley joined Standard in 1926 upon completion of his college studies. He since has served as petroleum engineer in southern California and in the company's home office in San Francisco. In 1943 he was named supervising petroleum engineer in San Francisco and held that position at the time of his recent appointment.

● **Louis J. Mittelman,** chief chemist, Avon Refinery, Tide Water Associated Oil Company, was the principal speaker at one of the regular sessions of the Western Oil Burner's Distributors Association meeting Saturday, May 10, at Santa Cruz, California.

● **Ernest E. Hitt** has been named manager of the Denver City, Texas, store of Oil Well Supply Company, it is announced by K. B. Winstead, division manager.

Hitt joined "Oilwell," U. S. Steel subsidiary, as a warehouseman at Odessa, Texas, October 7, 1937. Since that date he has served in stores at Hobbs, New Mexico, and Denver City, Texas, and in August, 1946, moved to Big Spring as store man.

Hitt succeeds B. I. Castle, who has assumed the duties of field representative at Odessa.

● **G. W. Wallace** has been advanced to the position of superintendent in charge of the Freedom Refinery after serving for more than 10 years as chief chemist in charge of Developmental and Refinery Laboratories. This announcement was made by B. L. Heath, vice president in charge of manufacturing for Freedom - Valvoline, Beaver, Pennsylvania.

G. W. Wallace

Wallace joined the Freedom-Valvoline Oil Company shortly after his graduation from Geneva College. His entire business career has been devoted to the processing of high quality petroleum products. His extensive experience has given him intimate contact with all refinery operations.

For a number of years Wallace conducted a Penn State College extension course in petroleum refining. In his new capacity he succeeds L. H. Major, who was promoted to manager of Freedom-Valvoline's pipe line division.

● **Vernon S. Anderson** of Libertyville, Illinois, has been appointed as a communications field engineer for Motorola Inc. He will have the northern Illinois territory. Prior to his association with Motorola Inc., Anderson was a field engineer, and later sales engineer in the broadcast division of Raytheon Manufacturing Company. During the war he taught at the Naval Research Laboratory in Washington, D. C., and also served aboard the USS Thrush in the South Atlantic.

● **John Eckel,** vice president in charge of engineering for Oil Center Tool Company, Houston, Texas, left early in June for an extended tour of South American oil operations. Eckel plans to spend about one month in the Lake Maracaibo area. He will then join Val R. Wittich, export representative for the company, in Caracas and visit Eastern Venezuela, Colombia, and other active areas.

John Eckel

● **W. C. Philley,** manager of Oil Well Supply Company's Wichita Falls, Texas, store since January, 1946, has been appointed division credit manager for the U. S. Steel subsidiary's Gulf Coast Division, Paul H. Shepherd, division manager, announced. His headquarters will be in Houston.

Philley joined "Oilwell" in Dallas July 25, 1935. Between 1937 and 1941, he served in stores at Beaumont, Houston, and Luling, Texas, becoming manager of the latter store in June, 1941, a position he held until going to Wichita Falls.

Philley succeeds J. W. Turner, resigned.

● **Joe T. Dickerson** has been appointed Houston area manager for Shell Oil Company, Inc. Former general attorney, regional staff, Dickerson succeeds **W. A. Alexander,** who is leaving Houston to become area manager at Tulsa, Oklahoma.

● **Henry M. Schmitt,** chemical industry manager for Brown Instrument Company, discussed automatic chemical process control at a joint meeting of the Royal Swedish Academy of Engineering and Science and the Association of Technical Physicists at Stockholm, Sweden, June 7.

During his stay abroad Schmitt will visit several European countries that are now looking to the United States for modern electronic and other automatic industrial instruments for improved processing and manufacturing. He will make headquarters at Honeywell-Brown European offices in Great Britain and on the Continent.

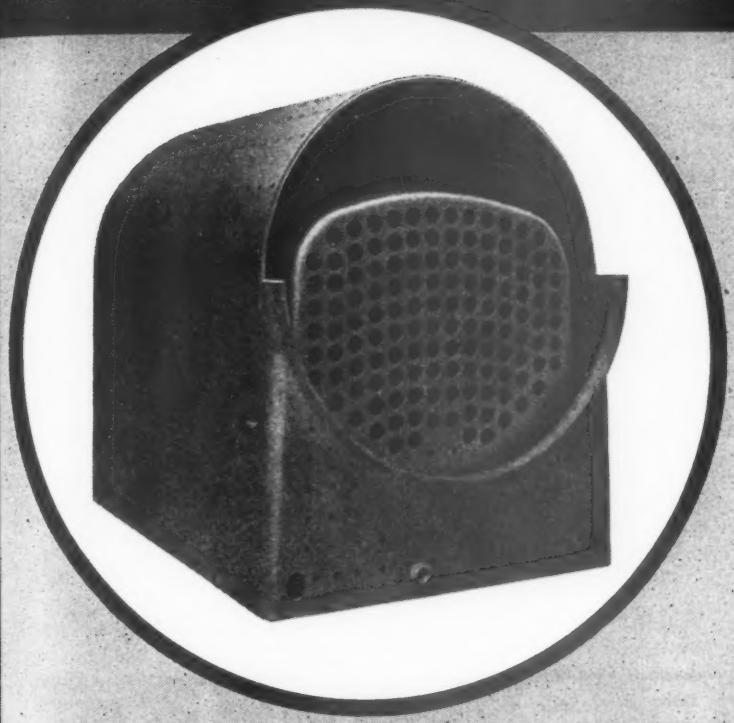
● **Robert G. Cady** has been appointed manager of the Materials Handling Division of the Ajax Flexible Coupling Company, Inc., Westfield, New York.

IT'S THE *Inside* CONSTRUCTION THAT COUNTS

FARRAR & TREFFS Streamline Welded BOILERS

TRADE MARK

150 Horsepower . . . 350 · 400 · 500 lbs. Working Pressure



FIREBOX SIDES ARE SLANTED 3"
To prevent "blanketing" of watersides with vertically rising steam.

Result: Quick steaming and more Steam per Hour.

WATERLEG TAPERS FROM 4" TO 5"
To give faster Water Circulation.

Result: Better Heat Transfer or Less Fuel to Make Steam.

LARGE WATER VOLUME: 2610 Gallons
To assure Smooth Operation without sudden Pressure Drops.

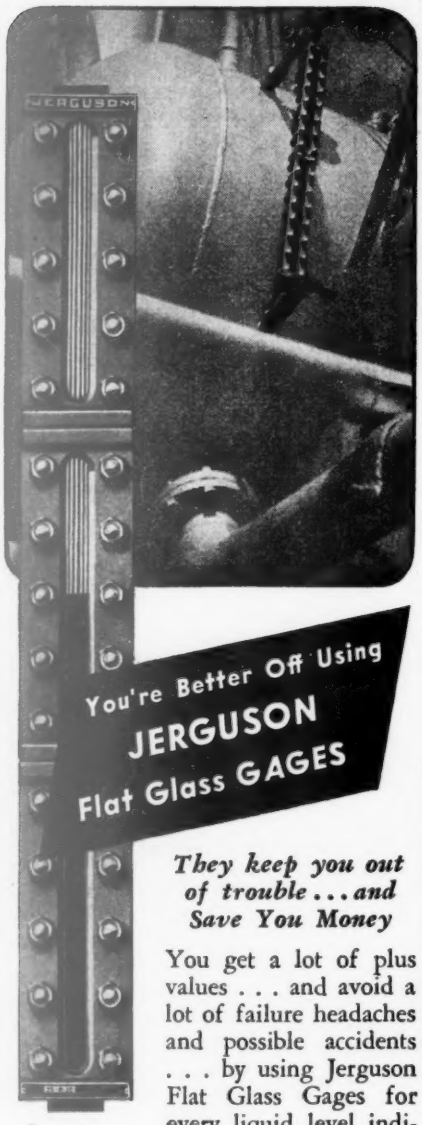
ALL-WELDED: No obstructions inside or outside ▲ No joint repairs or failures ▲ Quicker cleaning and washing ▲ Easier handling ▲ Lower maintenance expense

Added Feature *
Lower Half of Barrel extended to protect Smoke Door in Handling of Boiler
*Patent applied for

SAFER · STRONGER · LIGHTER

CONTINENTAL

THE CONTINENTAL SUPPLY COMPANY, General Offices: DALLAS, TEXAS • EXPORT DIVISION: 30 Rockefeller Plaza, NEW YORK, N. Y.
Representatives: ARGENTINA • BOLIVIA • BRAZIL • CHILE • COLOMBIA • ENGLAND • JAVA • MEXICO • PERU • TRINIDAD • VENEZUELA



Jerguson Reflex Gage

They keep you out of trouble . . . and Save You Money

You get a lot of plus values . . . and avoid a lot of failure headaches and possible accidents . . . by using Jerguson Flat Glass Gages for every liquid level indicating use.

You get the kind of gages and valves you want to do YOUR JOB. Jerguson offers you the most complete line available. Jerguson offers you an engineering organization specializing in building special gages to meet problems.

Jerguson Flat Glass Gages save money and labor. They are easy to install. They stand up . . . you don't have to keep servicing them or replacing the glass. They are available in a wide range of sizes, pressures, designs and materials; also with polished end stems to replace present tubular gages.

Write us about your problems or requirements.

JERGUSON
GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON

● **Roy W. Maze** has been appointed public relations director of The Marley Company, Inc., Kansas City, Kansas, manufacturers of nozzles, cooling towers, and other water cooling equipment. Maze entered the employ of The Marley Company in November, 1946, and succeeds **Charles B. Briggs, Jr.**, who is now production manager of the Kansas City, Kansas, plant.

Roy W. Maze

Maze received his B.S. degree in mathematics and physics from the College of Emporia at Emporia, Kansas, and his masters degree from the Kansas State College of Agriculture and Applied Science at Manhattan, Kansas.

Prior to his service with The Marley Company, he served as director of technical publications for three years at the Aireon Manufacturing Corporation in Kansas City.

● **Hugh A. Neal**, assistant manager of the Perco Division of Chemical Products Department, Phillips Petroleum Company, was recently awarded the Silver Star for gallantry in action. The award was presented on April 12 at Fort Sill, Oklahoma, by Major General Andrus, Commanding General of the Field Artillery Center.

During the war Neal held the rank of lieutenant colonel and commanded the 463rd Parachute Field Artillery Division. On May 29, 1944, this division was attacking the town of Artena, Italy, then being defended by the crack troops of the Herman Goering Division. During a skirmish Neal went forward to select advance military positions and was wounded by enemy artillery fire; however, he continued his reconnaissance until arrangements for the displacement forward were completed. Later when the enemy counterattack pierced our lines Colonel Neal continued to direct the fire of his battalion and was wounded again. Again he refused to quit the battlefield until the enemy was stopped.

● **Gaynor H. Langsdorf** has been elected a vice president and director of Oronite Chemical Company, in charge of products and processes. He has been manager of technical services in the manufacturing department of the Standard Oil Company of California, Oronite's parent company.

In his new position, he will be responsible for activities relating to manufacturing, research, and product development. He also will act in a liaison capacity in these matters with Standard and its research subsidiary, California Research Corporation.

Milton L. Baker will continue as vice president in charge of sales and related activities.

In another change, **Norman N. Gay**, previously manager of Oronite's Product Development Division, has been transferred to Standard's Special Products Division.

MERCOID

"DA"
CONTROLS FOR PRESSURE OR TEMPERATURE IN EXPLOSION-PROOF HOUSING

Mercoid "DA" Controls are particularly suited for the accurate and dependable service required on many essential industrial applications.

The outside double adjustment feature permits setting of the control without removing the explosion-proof case cover. The accurately calibrated dial and pointers indicating the operating range, are plainly visible through the shatter-proof glass cover. The direct reading eliminates guesswork.

A heavy Bourdon tube actuates the mercury switch. The Mercoid corrosion-proof mercury switch assures positive make and break in the electrical circuit during years of continuous performance.

For complete data see Mercoid catalog No. 600. A copy will be sent upon request.

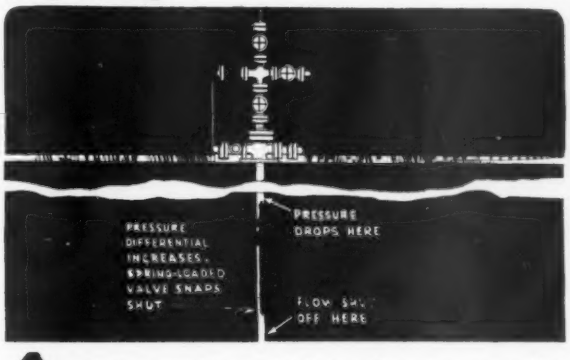
THE MERCOID CORPORATION • 4205 W. BELMONT AVE. • CHICAGO, ILL.

Otis Removable Tubing Safety Valve automatically shuts off flow in damaged well located near big Louisiana bridge

1 "On July 3, 1942, we received a request from a major company to install an Otis Removable Tubing Safety Valve in one of their Westwego Field wells. Inasmuch as this 7000 foot well had been completed in the low marshy land near the Mississippi and less than a mile from the Huey Long Bridge, New Orleans, the company was fully aware of its vulnerability to high water and the damage which might occur to local transportation and property in case surface connections ever failed or became damaged and allowed the well to flow wild.

2 "Since the tubing had already been run, we chose to install a Type FB Safety Valve which can be set at any desired depth. We then observed flow tests and selected an orifice for the Safety Valve bean which would allow a desired maximum rate of flow at 1700 p.s.i. and set the compression of the coiled spring, which holds the Valve in an open position, to equal a differential pressure of 500 p.s.i. In other words, in case the upward thrust of the pressure differential across the flow bean exceeded that of the spring, the valve would automatically close and shut off all flow through the tubing.

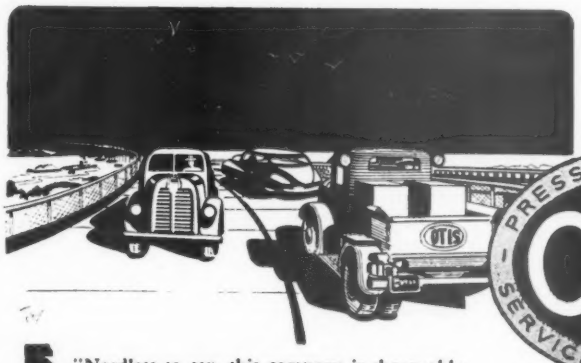
3 "On March 7, 1943, nine months after this installation had been completed, the company called again and asked us to send a service crew to this same well as soon as possible. When we arrived we learned that flow had stopped and that they wanted us to pull the Safety Valve, clean the well, re-set the Safety Valve, and put the well back on production. Inasmuch as it had been operating normally at 1700 p.s.i. on the previous day, it was their belief that the well had sanded up. When the crew arrived they rigged up our regular wire line equipment used to run and pull Otis Removable Sub-Surface Controls and checked for sand. However, they found none.



4 "Further inspection revealed that Xmas tree connections were practically cut off and damaged beyond repair. The surface choke was completely cut out and the wing valve was so badly damaged that it would not close. Thus, it was immediately evident that our automatic "Storm Choke" had performed its job quickly and efficiently. When surface connections began to fail the increase in rate of flow caused an increase in differential across the Safety Valve in excess of that for which the Valve was set, and the automatic mechanism snapped shut and prevented disastrous uncontrolled flow through the tubing.

This is the fourth in a series of advertisements covering actual installations of Sub-Surface Controls and subsequent service as described by Otis Pressure Control, Inc., field personnel. Except for necessary deletion of company and trade names these reports are unedited. For further details on equipment and service, write Otis Pressure Control, Inc., P. O. Box 7206, Dallas.

(T-5)



5 "Needless to say, this company is thoroughly 'sold' on the installation of Otis Removable Tubing Safety Valves in wells completed near rivers, highways, industrial areas or townsites, and in other critical zones. Although they had maintained constant check on this particular well, connections failed without warning, and only by their foresight of having installed automatic sub-surface protection was incalculable damage and financial loss avoided."

PRESSURE CONTROL — OTIS — SERVICE + EQUIPMENT

T. M. REG.

OTIS PRESSURE CONTROL, INC.

FIELD OFFICES: **TEXAS:** HOUSTON, CORPUS CHRISTI, and LONGVIEW. **OKLAHOMA:** OKLAHOMA CITY. **NEW MEXICO:** HOBBS. **LOUISIANA:** NEW IBERIA

OTIS ENGINEERING CORPORATION — MANUFACTURE AND DEVELOPMENT

DISTRIBUTORS: **OTIS PRESSURE CONTROL, INC.,** DALLAS, TEX.; **OTIS EASTERN SERVICE, INC.,** BOLIVAR, N. Y.; **WESTERN PRESSURE CONTROL,** LOS ANGELES, CALIF.

EXPORT SALES AND SERVICES: **OTIS PRESSURE CONTROL EXPORT, INC.,** POST OFFICE BOX 7206, DALLAS, TEXAS, U. S. A.; CARACAS, SOUTH AMERICA

QUEBRACHO

MIMOSA

ADCO POWDER
No. 62

•

These three products are interchangeable for drilling fluids.

•

They are Spray Dried powders with a moisture content of less than 5 per cent and therefore stable in any climate.

•

Easily soluble in hot or cold water.

•

MANUFACTURED AT
CHESTER, PA.

•

WRITE FOR SAMPLES

AMERICAN
DYEWOOD
COMPANY

22 East 40th Street
New York (16) N.Y.

She has an ermine coat, a foreign car,
A ten room flat with a built-in bar
And she does it all on thirty per—
Believe it, that's the truth, dear sir,
Yet five years back some teaching hick,
Flunked this gal in arithmetic!

* * *

Boss: You can't ask for a raise like that. You must work yourself up.

Salesman: I did, I'm trembling all-over.

* * *

Husband: When anything goes wrong around the house, I always fix it.

Wife: Oh, yeah? Since you fixed the clock, the cuckoo backs out and asks "What time is it?"

* * *

"Did you fish with flies?"

"Fish with flies? Yes, we fished, camped, dined, and slept with them.

* * *

The club members were bidding farewell to one who was leaving for India. In the conversation a friend said, "It gets pretty hot in India at times. Aren't you afraid the climate might disagree with your wife?"

The man looked at him reproachfully. "It wouldn't dare."

* * *

Two college presidents were discussing what they'd like to do when they retired. "I'd like to be superintendent of an orphans' home—no letters from parents," said one.

The other suggested: "Why not be a penitentiary warden? The doggone alumni don't insist on coming back."

* * *

If little Red Riding Hood lived today
The modern girl would scorn her.
She only had to meet one wolf,
Not one on every corner.

* * *

Stranger: What's the whistle blowing for?

Native: There's a fire somewhere.

Stranger: But why do they blow the whistle for a fire?

Native: They don't blow it for the fire. They blow it for the water. They already have the fire.

* * *

"The true value of horse sense is clearly shown by the fact that the horse was afraid of the automobile during the period in which the pedestrian laughed at it."

* * *

For nearly a year one of Hollywood's biggest producers had been looking for a really good story, and had at last reached the point where he was ready to listen to all comers.

One day an unknown writer was ushered into his presence.

"They tell me you have a great play," said the producer, with a reassuring wave of the hand. "Go ahead and read it to me."

This was more than the author expected. Furthermore, he was afflicted with a severe stutter. But the chance was too good to miss, so he sat down and read the whole play, scene by scene.

When he had finished the producer yelled for his secretary.

"Sign this man at once," he cried. "He's got a new twist that's sure box office. Every character in the story stutters!"

* * *

A worried man walked into the office of the Rent Control Administrator and asked if anyone could tell him who his landlord was.

Clerk: Your landlord is the man you pay rent to.

Man: I don't pay no rent. You see 'bout nine years ago I found me a vacant house and moved in. I been there ever since and I ain't paid no rent.

Clerk: Well, then, what are you worrying about? You have no complaint.

Man: Yes, sir, I have, if somebody don't fix that roof, I'm gonna move out.

* * *

A minister was asked by one of his members to say prayers on Sunday for Anna Belle. The clergyman did so. A few days later the pastor asked the church member if he desired the prayers for Anna Belle to be repeated.

"Thanks, no," replied the member. "She won last Wednesday at seven to one."

* * *

Up to the age of sixteen a boy may be a boy scout. But from that time on he's a girl scout.

* * *

She: How about giving me a diamond bracelet?

He: My dear, extenuating circumstances perforce me to preclude you from such a bauble of extravagance.

She: I don't get it.

He: That's what I just said.

* * *

Mental Specialist: And that habit of talking to yourself—that's nothing to worry about.

Patient: Maybe not—but I'm such a damned bore!

* * *

The good old days were those when Uncle Sam lived within his income—and without most of ours.

* * *

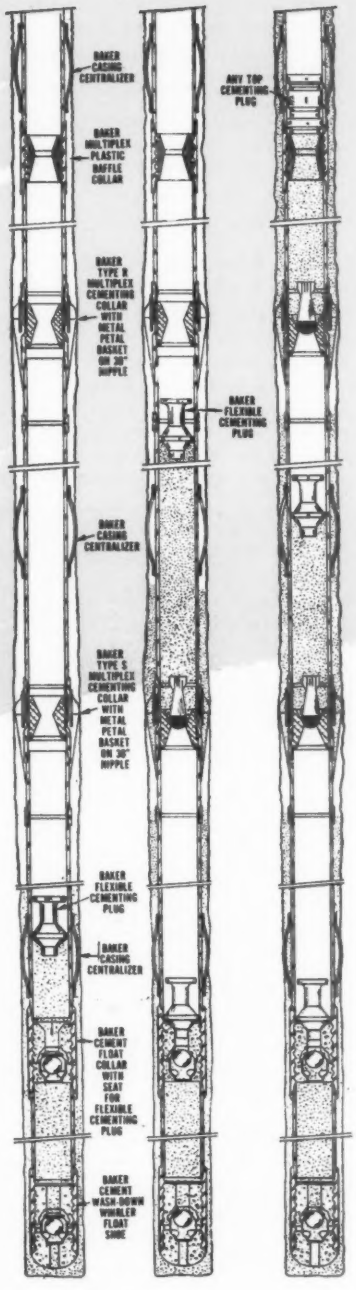
It's been suggested that when the present divorce wave subsides, someone should publish a "Who's Whose."

* * *

Golfer (to players ahead): Would you mind if I played through? I've just been notified that my wife is seriously ill.

FOR MULTIPLE-STAGE JOBS...

Baker Multiplex Cementing Equipment!


BAKER CASING CENTRALIZER
BAKER MULTIPLEX PLASTIC BAFFLE COLLAR
BAKER TYPE B MULTIPLEX CEMENTING COLLAR WITH METAL PETAL BASKET ON 30" NIPPLE
BAKER CASING CENTRALIZER
BAKER TYPE S MULTIPLEX CEMENTING COLLAR WITH METAL PETAL BASKET ON 30" NIPPLE
BAKER FLEXIBLE CEMENTING PLUG
BAKER CASING CENTRALIZER
BAKER CEMENT FLOAT COLLAR WITH SEAT FOR FLEXIBLE CEMENTING PLUG
BAKER CEMENT WASH-DOWN WHIRLER FLOAT SHOE
ANY TOP CEMENTING PLUG
BAKER FLEXIBLE CEMENTING PLUG

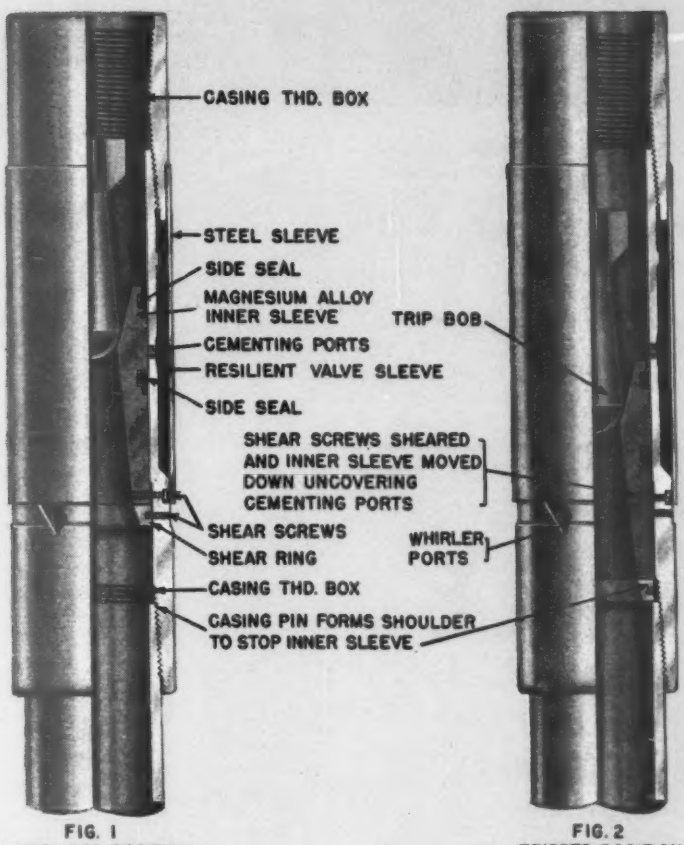


FIG. 1
UNTRIPPED POSITION

FIG. 2
TRIPPED POSITION

Developed for depositing a continuous encasement of cement around a blank string of casing at pre-determined intervals, to make sure that the cement completely fills the annulus, and that channeling is reduced to a minimum.

Eliminates necessity for auxiliary cementing string, special running-in or cementing tools of any kind. Variety of combination hook-ups to meet different well conditions and cementing problems. Use of Slidably Mounted Metal Petal Basket greatly increases probability of successful initial water shut-off. Adaptable to either plug or displacement cementing method for each stage of a multi-stage cementing job.

SIMPLE CONSTRUCTION — POSITIVE OPERATION

The specially designed Multiplex Cementing Collar with male and female threads, or double female threads as shown above, is provided with whirler cementing ports and a resilient sleeve (reinforced with bias canvas) which acts as a back-pressure valve on the periphery of the collar and is protected by a steel sleeve around its exterior. A magnesium alloy inner sleeve, with a tapered hole through its center, covers the cementing ports and is held in place by shear screws until tripped. The mechanism is operated by a Trip Bob made from a hollow magnesium alloy casting, filled with lead to give it sufficient weight. This Trip Bob has a resilient seal on the lower end for sealing off in the seat of inner sleeve.

NEW BULLETIN GIVES ALL DETAILS

A new 8-page bulletin contains specifications on BAKER Multiplex Cementing Collars and auxiliary equipment. Illustrates and describes how to perform Two-Stage and Three-Stage Cementing jobs and contains other interesting data. Any oil man is welcome to a copy—ask for yours today.

BAKER OIL TOOLS

BAKER OIL TOOLS, INC., LOS ANGELES • HOUSTON • NEW YORK

To new posts

Appointment of John A. Worthington as general sales manager of the Piston Ring Division of Koppers Company, Inc., has been announced by Allen W. Morton, vice president and general manager of the division.

At the same time, Morton announced that T. Latimer Ford, who has been with Koppers or its affiliates since 1908, and has become widely known in the piston ring field, will head up a new company department devoted exclusively to replacement sales.

In announcing the appointments, Morton said:

"In his new position, Worthington will assume responsibility for unifying and directing all sales activity of the division, looking forward to increasing service to customers and ultimate expansion of the division's scope of operations.

"Our plans include not only expanded activity in the domestic field, but in the foreign market as well.

"In the replacement sales department to be headed by Ford, our increased activity will be carried into the automotive, industrial, marine, oil industry, and aircraft fields."

Worthington is a native of Annapolis, Maryland, and joined the Bartlett Hayward Company, now a division of Koppers, in 1916 after attending St. Johns College and Johns Hopkins University night school.

At Bartlett Hayward he began as an inspector and in three years became a foreman. In 1920 he was transferred to the American Hammered Piston Ring Division as assistant shop superintendent. Two years later he became an engineer in that division and since 1925 has been manager of industrial sales and engineering.

Ford joined the Bartlett Hayward Company in 1908 and in 1919 became assistant secretary and treasurer of the American Hammered Piston Ring Company. In 1921 he was made Pacific Coast district sales manager of the company, and in 1927 became vice president and sales manager.

When American Hammered was consolidated with Koppers in 1936, the position of vice president was abolished and Ford became sales manager of the company's automotive division.

Use Acme Cable Tools

Trustworthy Since 1900

Acme Wire Line Cutting Outfit

assures the cleanest-cut, quickest, safest means of parting drilling cable from a string of stuck tools . . . A known fact — based on years of stern field-tested service — as verified by its many satisfied users.

Designed and patented by a noted, practical, old-time operator, this unique outfit is an Acme favorite . . . Possesses ALL the correct-steel, proper heat-treatment safeguards and precision-engineered craftsmanship that have made Acme Tools famous: for your trustworthy use.

An exclusive feature is the Wire Line Knife's cutter arrangement — cutter-edges so spaced that each cuts a separate strand, but the cable is ALL severed with ONE bite. Thus avoiding frayed ends. Cutters of toughest known tool steel. (This outfit, less cutters, may be used as jar bumper — sometimes freeing stuck tools, without cutting cable.)

Outfit consists of Knife (Fig. 179), Jars, Sinker and Rope Socket — run in this order. Two tool wrenches furnished. . . . Cuts any size line, in any hole 4" and up. Special sizes made for tubing use. (With simple precautions, the outfit is run without wrapping. See our catalog instructions.)

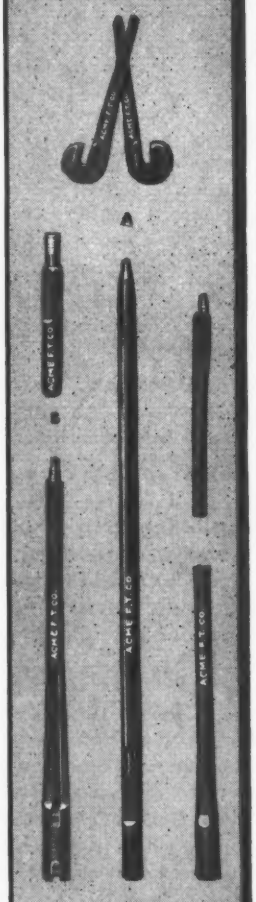
Shown here is W.L. Cutting Outfit, complete —fashioned to Acme's rigid requirements— for your more profitable use.

Fig. 179
Acme Wire Line Knife Cutters

Fig. 180
Cover Plate

For more information, see our 24-page Catalog in Composite Catalog (Vol. 1). Or tell us your needs, by TODAY'S mail.

In Acme Tools, There's More of EVERYTHING You Need



A—Tool Wrenches
B—Rope Socket
C—Wire Line Knife
D—Long Stroke Jar
E—Sinker

Acme Fishing Tool Co.

PARKERSBURG, W. VA.

Export Office: 19 Rector St., New York 6, N. Y.

Since 1900

Rejoins Chrysler staff

David A. Wallace, president of the Chrysler Division, Chrysler Corporation, announces the appointment of John T. Condon as a sales executive of the division. As such, Condon becomes a member of the general sales staff, whose other members are Stewart W. Munroe, general sales manager; Joseph A. O'Malley, assistant general sales manager; Earl B. Wilson, director of sales, and Roy H. Appleman, sales executive, with Wallace heading the group as well as all other divisional activities.

J. T. Condon

J. C. Hammelef

Condon returns to the sales department after spending the last five and a half years as manager of the Industrial Engine Division of Chrysler Coporation. He is succeeded in that position by John C. Hammelef, a long-time member of the Industrial Engine Division staff.

Otis promotions

H. C. Otis, president, Otis Pressure Control, Inc., Dallas, Texas, has announced the advancement of Turner G. Garwood to the position of sales manager and Harry B. Schramm to field engineer.

Garwood was employed by Otis in 1937 and, having served in virtually every field and engineering capacity offered by the company, carries a wealth of operating knowledge and experience into his new position. Until recently he was division superintendent of Otis Pressure Control, Inc., Northern District, in Oklahoma.

Garwood will have his office in Hous-

ton, 6705 Navigation Boulevard, and will devote his time to personal contact of oil and gas well operators in order to lend added experience to the study of high pressure production problems and possible solution through use of Otis sub-surface controls and services.

Schramm was graduated from Texas

T. G. Garwood

H. B. Schramm

A. & M. as a petroleum engineer in 1937. From that date until his call to active duty in the armed forces in 1942, he was employed as a consulting engineer in secondary recovery and as district engineer and assistant superintendent of West Central Texas for Fain-McGaha Oil Corporation. He joined Otis in January, 1946, and will continue to use the general offices in Dallas as his base of operations.

Production manager

Charles B. Briggs, Jr., has been appointed production manager of the Kansas City, Kansas, plant of The Marley Company, Inc., manufacturers of cooling towers, nozzles and other water cooling equipment.

C. B. Briggs, Jr.

Briggs, who has been with The Marley Company since September, 1944, as application engineer and public relations director, succeeds E. A. Ostrom who is now manager of the Marley Stockton plant.

Briggs received his B. S. degree in mechanical engineering from the University of Missouri. He also did graduate work at the University of Missouri, the University of Kansas, and Kansas City University.

Oil-Field sales chief

Paul Randels

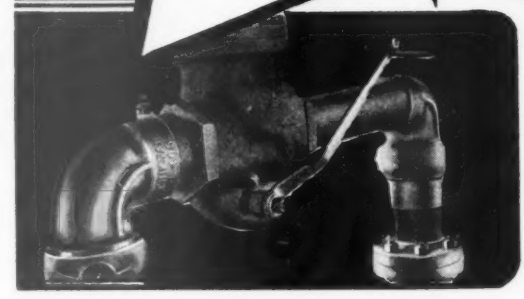
Sales and operations directions of the Oil Field Division of Black, Sivalls and Bryson, Inc., have been concentrated in Paul Randels, formerly with the company at Fort Worth, Texas.

Randels will move his executive headquarters to Kansas City, and will cover the field extensively, coordinating all oil-field sales activities in BS&B branches and sales offices.

Now CHIKSAN OFFERS THE PERFECT COMBINATION For LOADING LINES

CHIKSAN BALL-BEARING SWIVEL JOINTS

Okadee LOADING RACK VALVES



OKADEE LOADING RACK VALVES are now distributed exclusively by Chiksan Company and Chiksan Export Company. Okadee Valves have been "working on the railroad" for 50 years... and serving the Petroleum Industry for a quarter-century. The combination of Chiksan and Okadee now makes possible uniformly high standards in Loading Rack design and performance.

CHIKSAN SWIVEL JOINTS have always been noted for their unobstructed inside diameter which permits full flow. Okadee Loading Rack Valves provide corresponding high capacity. In combination, they improve loading efficiency and substantially reduce loading time. Low pressure drop saves pumping costs. Non-shock closing prevents damage to equipment. Easy operation at all pressures gives the operator perfect control. Chiksan Ball-Bearing Swivel Joints provide full 360° rotation with low torque. There is nothing to tighten or adjust. You get ALL these advantages when you specify Chiksan and Okadee for Loading Rack service. Write for full details.

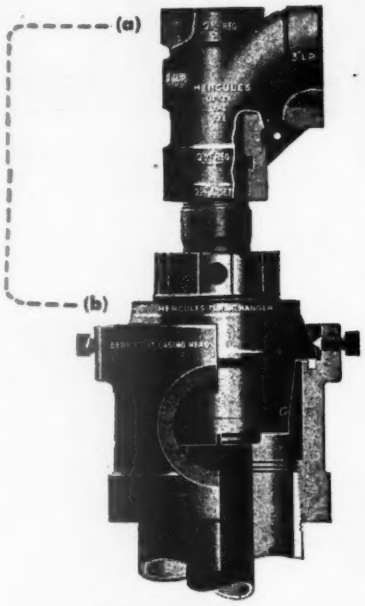
CHIKSAN REPRESENTATIVES IN PRINCIPAL CITIES

EXPORT REPRESENTATIVE: Chiksan Export Co., Brea, California

Branches: New York 7, Houston 1

CHIKSAN TRADE MARK REGISTERED BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY BREA, CALIFORNIA New York 7 Houston 1



FULLY PATENTED

WHAT A DIFFERENCE...

HERCULES PUMPING WELL HOOK-UP MAKES!

Note how the Hanger sits down in the casing head out of the way; the compactness of the entire hook-up . . . reducing the number of connections necessary in connecting a well the old way.

(a) Hercules Pumping and Flowing Tee is the original and only Tee with a combination Plain and EUE thread. (Supplied in any combination.) Heavier and stronger than an ordinary Tee.

(b) Hercules Forged Steel Tubing Hanger—with Forged Steel Slips on which tubing hangs—affords absolute tubing protection. Has the FAMOUS Hercules Packing above slips with threaded nut to distort packing, independent of tubing weight. (Fits any Berry Pattern Casing Head.)

Sold at all supply stores

HERCULES TOOL COMPANY

TULSA, OKLAHOMA, Box 286
EXPORT OFFICE: 30 Rockefeller Plaza
NEW YORK, U.S.A.
CABLE ADDRESS: HERTOCO

New method of drilling wells

A WORKING model of a new electrical motor-driven rotary drilling unit was shown recently to a group of petroleum engineers and writers at Bartlesville, Oklahoma, by A. Arutunoff, the inventor, who is president of the Electrodrill Corporation of Delaware, owner of the patents. The accompanying sketch of the new drilling unit shows the general arrangement of the various parts.

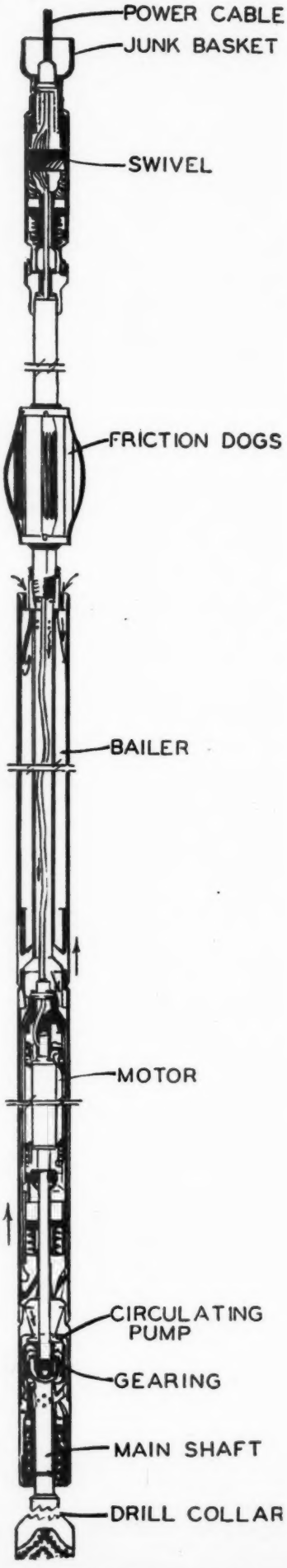
The drilling unit is lowered into the hole on a special steel-wire-covered electrical power cable. The motor in the drilling unit is controlled by a switch at the surface. The electrical current is turned on when the drilling unit reaches the bottom of the hole. A reckoning ammeter measures the current used by the submerged drilling motor. The friction dogs tend to prevent the drilling unit from turning as the bit turns, but do not interfere appreciably with upward and downward movement of the unit. The swivel is designed to prevent the electrical cable from snarling should the dogs fail to hold.

The drilling unit must be at least submerged in mud or water so that the circulating pump can keep the water circulating down through the bit and back up the outside of the unit to the top of the bailer. The drill cuttings are washed up and retained in the bailer, which may be 30 to 60 ft long, depending upon the length of hole that the operator desires to drill on each trip. The cuttings from a 15 or 20-ft section of hole might fill a 30-ft bailer.

The junk basket is designed to retain pieces of rock that might cave in on the unit, so that identification and remedial work can be done on that part of the hole above the unit. Caving formation encountered must be cemented off and redrilled to prevent sticking the unit at the bottom of the hole.

The length and size of the submerged electric motor depends upon the amount of torque required to turn the drill collar and bit. This, in turn, will depend upon the formation being drilled and the type of bit. The motor in the first unit operates at 3600 rpm, and the drill collar and bit turn 300 rpm. Drilling progress is measured by the length of power cable fed into the hole.

The working model shown to the group at Bartlesville weighs 1700 lb. It was equipped with a 1000-lb drill collar and 6⅛-in. rock bit. It is the first and only drilling unit of this kind that has been built by the company, and it has been used experimentally to drill and core about 160 ft of hole. The drilling unit itself may be 70 ft or more in length depending upon the length of the bailer and the length of the motor selected for a given job.



Director of laboratories

C. G. Kirkbride, prominent in engineering circles and former professor of chemical engineering at Texas A & M College, has joined Houdry Process Corporation as director of the Houdry Laboratories, Arthur V. Danner, Houdry executive vice president, has announced.

C. G. Kirkbride

Kirkbride will make his headquarters at the modern Houdry laboratories where more than 350 research people are employed in the eight research buildings erected on seven acres of land near Marcus Hook, Pennsylvania.

Kirkbride taught chemical engineering at Texas A & M for two years after having served as chief of chemical engineering development for Magnolia Petroleum Company at its Dallas Research Laboratories. His long experience in the oil industry includes positions as assistant director of research for Pan American Refining Company and as research engineer with Standard Oil Company of Indiana.

The new director of Houdry Laboratories is chairman of the program committee for the American Institute of Chemical Engineers and is a director of the AIChE, serving on a number of other important Institute committees.

"Kirk" was among those scientists who traveled to Bikini Atoll as scientific observers during the joint Army and Navy atomic tests at "Operation Crossroads" in 1946.

W. A. Olen named

Walter A. Olen, president of The Four Wheel Drive Auto Company, Clintonville, has been named Wisconsin vice president of the National St. Lawrence Association, according to an announcement by Julius H. Barnes of Duluth, president of the organization. Olen replaces the late Leathem D. Smith, of Sturgeon Bay, formerly president of the Sturgeon Bay Shipbuilding Corporation, who lost his life last summer on Green Bay.

W. A. Olen

Long an advocate of the completion of the facilities of the St. Lawrence Waterways for handling large ocean going ships, Olen favors the completion of the canal and lock facilities in order to expedite the shipment of Wisconsin and midwest manufactured items and agricultural produce directly from the Great Lakes ports to seaboard cities and foreign countries.

FORGED STEEL UNIONS

Your Most Dependable Servants

Petro UNION

America's most universally used Union! A partial list of proven services: Pressures from a vacuum to 3000 lbs. Temperatures from 100° below zero F. to 1000° above zero F. Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and all service in which Steel or Wrought Iron Pipe is used. Made to A.A.R. Standards and priced in line with 300 lb. A.A.R. Malleable Iron Unions.

Write for Pamphlet AM-67

SIZES ⅛" to 3"

Socket Weld UNION

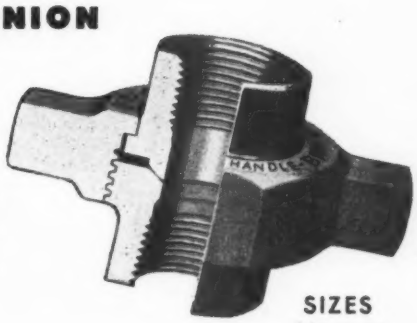
This is our "PETRO UNION" with the end pieces reamed to U.S. Navy Specification B-173 for socket welding. Ends squared to facilitate welding. It has permanently lubricated nut threads and machined and cold rolled steel seats.

Write for Pamphlet AM-67.

SIZES ¼" to 3"

Handle-Bar UNION

4000 AND 6000 TEST



4000 Test: Sizes ⅜" to 1½" V-thread in nut.

4000 and 6000 Test: Sizes 2" to 4" modified Acme Threads in nut.

Steel to steel, or bronze to bronze cold rolled seats. Permanently lubricated nut threads. To tighten, or loosen the nut, USE A HAMMER INSTEAD OF A WRENCH.

Write for pamphlet 4P-HB.

SIZES ⅜" to 4"

ORDER BY TRADE NAME FROM YOUR JOBBER

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

Personnel changes

Key personnel changes in three of the organization's 11 field divisions have been announced by officials of Halliburton Oil Well Cementing Company.

H. P. Hearn, who joined the company in 1925 as a truck driver and cementer's helper at Henderson, Texas, has been promoted from assistant superintendent to superintendent of the East Texas division, with offices in Kilgore and Dallas. He replaces W. H. Baker, who resigned to enter the contracting business with Jay Taylor in the firm of Baker and Taylor, Amarillo, Texas.

Hubert L. Northcutt, superintendent of the South Texas division for the last two years, has been transferred from Houston to Flora, Illinois, where he will direct the company's operations in Illinois, Indiana, Kentucky, Ohio, Michigan, and West Virginia. Northcutt joined Halliburton as a cementer's helper in 1923 at Refugio, Texas, and served successively as cementer, fieldman, assistant superintendent, and superintendent in the Gulf Coast area.

Replacing Northcutt in the South Texas territory is H. P. Conroy, superintendent of the Eastern division at Flora since June 1944. Prior to his transfer to Illinois in 1938, Conroy worked as cementer and fieldman in Louisiana and Texas. His experience with Halliburton dates back to 1928, when he began driving a cementing truck at Freer, Texas.

EXCLUSIVE MID-CONTINENT REPRESENTATIVES: Hunt Tool Company, P. O. Box 1436, Houston, Texas
EXCLUSIVE EXPORT REPRESENTATIVES: Hunt Export Company, 19 Rector Street, New York City, N. Y. • Avda Pte. R. Saenz, Pena 832, Buenos Aires, Argentina

New ACF president

At a meeting of the board of directors of the American Car and Foundry Company, held May 29 at 30 Church Street, New York City, the resignation of F. A. Stevenson as president was accepted. Stevenson had been associated with ACF for more than forty years in various capacities.

C. J. Hardy, Jr.

Charles J. Hardy, Jr., who heretofore had served the company as its executive vice president, was elected to the presidency, succeeding Stevenson. Hardy served as an officer in the United States Naval Reserve in World Wars I and II. He is a graduate of Williams College, holding the degree of bachelor of arts, and is a member of the bar of the State of New York.

P. T. Paynes passes

Paul T. Payne, 67, district manager of Dearborn Chemical Company, Indianapolis, Indiana, died recently in Lebanon, Indiana, in which city he resided for more than six years.

Paul T. Payne

Forty-nine years ago Payne became associated with the Dearborn Chemical Company as a laboratory technician. This qualified him to assume the responsibility of various positions in the sales department, starting in the Chicago office, later as manager of the Philadelphia office, and for the last 36 years as district manager of Indianapolis office, covering the south and eastern part of the United States.

New stores opened

The Mid-Continent Supply Company, Fort Worth, Texas, announces the opening of the following stores.

Great Bend, Kansas, with V. H. Haston, store manager, and Paul K. Confer, field salesman.

New Iberia, Louisiana, with W. R. Shuffield, store manager, and H. M. LeCompte, field salesman.

Brookhaven, Mississippi, with W. M. Day, store manager, and C. R. Lowry, field salesman.

Pauls Valley, Oklahoma, with Paul Myers, store manager, and D. B. Afflack, field salesman.

Formula correction

In the article by Fred E. Hummel, published in the April issue of *The Petroleum Engineer*, an error was made in the horsepower formula appearing on page 120. In this formula (center column) the number 1400 inadvertently was substituted for what should have been 1440. Readers who have filed this article for future reference should note this correction.

Executive changes

Ken W. Davis, president of the Mid-Continent Supply Company, Fort Worth, Texas, announces the following promotions, transfers, and changes in top executives:

D. H. Thornbury, vice president, is being transferred from Houston, where he managed the Gulf Coast area, to the general offices at Fort Worth. His new position will be executive vice president directly under Davis.

Vice President J. A. Daugherty, now in charge of the Tulsa and Northern division, is taking over Thornbury's place at Houston and will be assisted by W. I. West, former West Texas-New Mexico division manager. West, who was previously located at Houston, will become the division manager of the Gulf Coast area.

D. H. Thornbury

J. A. Daugherty

W. I. West

S. R. Clinkscales

T. P. Tarwater

A. T. Skaer

The job of managing the Tulsa and Northern division is going to S. R. Clinkscales, former division tubular manager at Tulsa.

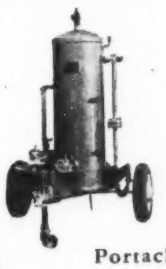
T. P. Tarwater, former district manager at Odessa, is being put in charge of the West Texas-New Mexico area, with A. T. Skaer as the new general district manager. This consolidated district includes in Texas, Odessa, Kermit, Fullerton, and Sundown, and in New Mexico, Eunice and Hobbs.

The Bowser Automatic Well-Check System furnishes an accurate, indisputable record of individual well production *quantity* and *quality*—puts each well on its own merits . . .

- Eliminates gauge tanks
- Stops evaporation losses
- Reduces pumping and transportation costs
- Minimizes fire hazards
- Furnishes true proportional sample
- Provides permanent, indisputable records
- Accurately records gross production
- Detects sleepers or wet wells

ENGINEERED TO HANDLE ANY TYPE OF OIL WELL PRODUCTION WITH THESE PROVED WELL-CHECK UNITS

1. Bowser Special Oil Well Xacto Meter—no metal-to-metal contact—VERTICAL PISTON operation for sustained accuracy and long life.
2. Bowser True Proportional Sampler.
3. Bowser SPILL-PROOF GAS TRAP with patented Peel-Off Valve—no packing glands—no valves to grind or adjust.



Portachek—the portable Bowser Well-Check Unit—is used to test the potential production of new wells before installing permanent Bowser Well-Check Systems.

BOWSER ESTABLISHED 1885

Write for complete information on Bowser equipment for modern oil fields.

BOWSER, Inc.

1329 Creighton Avenue, Fort Wayne 2, Indiana

LIQUID CONTROL SPECIALISTS SINCE 1885

J. B. O'Connor reports on Russia

Dresser Industries, Inc., Cleveland, Ohio, has orders from the Russian Government for eight deep-drilling rigs, 26 portable drilling rigs, 10 portable clean-out rigs, more than 100 pumping units, a liquid methane plant, and various other miscellaneous equipment, it is announced by J. B. O'Connor, executive vice president of Dresser, who just returned to this country after eight weeks spent in Moscow negotiating the sale.

The deep-drilling rigs, made by International Derrick and Equipment, one of the Dresser member companies, are the latest type, capable of drilling to 15,000 ft, with automatic controls that reduce manual labor to a minimum, hydraulic control type of transmission, and the latest Security bits of the type designed for deep drilling in the Rockies. These rigs will be used in the fields between the Volga and the Urals in the District of Kuibysheve.

The rambler rigs, with portable equipment capable of drilling to 6000 ft; the clean-out rigs, capable of operating to 9000 ft, and the pumping units—all three likewise Ideco products—will be put to work for rehabilitation purposes in the Maikop field that was virtually destroyed during the war.

"The Russian program of petroleum and gas rehabilitation and development, which is part of the current 5-year plan, is a really stupendous undertaking," O'Connor reports. "To understand it, one must bear in mind that the Russian program embraces plans for the entire nation; that it is much larger in its potentialities than would be a similar program conducted by any one company in the United States, and that eventual possibilities are unlimited because of the vast reserves of crude that as yet have hardly been tapped.

"In carrying out this program the Russians are using the finest and most modern type of equipment. I talked with top technicians in the production, refining, natural gas, and other divisions of the program who are truly experts in their fields and who uniformly possess an almost unbelievable capacity for a hard day's work. It was interesting that many of them had in past years spent some time in the United States and in fact I had first become acquainted with many of them upon their visits to the States in prewar years.

"As an example of modernization, in their cracking units they are now replacing pumps of the horizontal reciprocating type by those of the centrifugal hot oil type, such as those now made by Pacific Pumps, another one of our member companies.

"The Russians are determined to rehabilitate the fields destroyed by the war by clean-out, repair, and new drilling. In addition, they intend to develop new fields by deep-drilling methods just as modern as those employed in our own country.

"Of particular interest is the natural gas pipe line running between Saratov and Moscow. Moscow is not only a metropolis—it is a big industrial center. It is expected that the increased supply of natural gas to Moscow will relieve pressure on the railroads that are now overtaxed by carrying peat, lignite, and fuel oil.

"I inspected this pipe line. It is a good job. A compressor station on this line which I visited is not only up to the latest American technical standards but is designed furthermore to operate in temperatures as low as 40 F below zero.

"This is the line that will be served by the liquid methane plant to be designed and installed by the Stacey-Dresser Engineering Division of Stacey Bros. Gas Construction Company, another one of the Dresser member companies. This plant will handle storage of liquefied natural gas for standby and peak-load purposes."

On his European trip, in addition to Russia, O'Connor visited England, Sweden, France, Holland, and Ireland.

To Mid-Continent

The return of Robert C. Medearis to the Mid-Continent area is announced by Patterson-Ballagh, division of Byron Jackson Company, manufacturers of oil-field specialties.

Bob's old-field friendships and experience with Patterson-Ballagh date back to 1933. During the war he served 4½ years as a pilot in the USAAF and was discharged as a captain.

Under J. P. Magoffin, district manager of Patterson-Ballagh, whose office serves the entire Mid-Continent, Bob will be working out of Houston and helping to serve Patterson-Ballagh customers in the area.

Coast representative

E. H. Vockrodt, 3757 Wilshire Boulevard, Los Angeles 5, California, has been appointed Pacific Coast representative by Alloy Steel Products Company of Linden, New Jersey, manufacturers of corrosion resisting valves and fittings.

Vockrodt has been transferred to inactive status with the rank of lieutenant colonel, after four years of active duty with the Army Air Forces. Previous to his entry into the service he was manager of sales for Ducommun Metals and Supply Company and, earlier, with the Crane Co., calling on major oil accounts.

Elected vice president

Election of Ivan F. Baker as vice president of the Westinghouse Electric International Company has been announced by William E. Knox, president. Baker has been treasurer of the company since September, 1945, a post he retains along with that of director of the company.

Continental Supply Company holds sales meeting

The Continental Supply Company held a two-day sales meeting of the West and North Texas and New Mexico district key personnel on May 12 and 13 at the Blackstone Hotel, Fort Worth. With R. L. Collier, district manager, in charge, the 28 district men were addressed by F. I. Bringgar, executive vice president, N. A. Endicott, sales manager, and J. A. Mussler, manager of tubular sales, all of Dallas.

Moves advertising offices

Advertising headquarters of International Derrick and Equipment Company has been moved from Columbus, Ohio, to 1315 Pacific Avenue, Dallas, Texas, according to announcement made by O. M. Havekotte, president of the company. All advertising activity of the company will be handled from the office in Dallas under the direction of E. J. Whetzle, advertising manager. Fuller and Smith and Ross service the account.

E. J. Whetzle

Whetzle, who has directed Ideco's program for the last two years, is formerly from the Southwest where he handled the advertising for an oil field manufacturer at Shreveport, Louisiana. While in Columbus he was a director of NIAA and program chairman of Central Ohio Industrial Marketeers. He was also a member of the Columbus Advertising Club.

B. S. & B. reports

Black, Sivalls and Bryson, Inc., Kansas City, Missouri, has issued two interesting reports on its operations. One is the annual report covering the calendar year 1946, the other a quarterly report for the period of January 1 to March 31, 1947. Both reports indicate the progress of this company, one of the large manufacturers of petroleum industry equipment. For example, sales for year 1946 were in excess of $9,000,000, and net profits after dividends had been paid to shareholders were $858,847.61. The report covering operation for the first quarters of 1947 shows sales in excess of $3,000,000 and a net profit of $415,235.50.

A section of the annual report is devoted to a review of the growth and history of the company, from the first wooden tank made in 1893 to the present.

Larkin chief chemist

Joe Larkin has been appointed chief chemist in charge of rubber research for Patterson-Ballagh, division of Byron Jackson Company, manufacturers of oilfield rubber specialties.

Larkin graduated from UCLA as a specialist in organic and biochemistry. During the war he was assigned to research for the War Department. After the war, he served as chief chemist for L. A. Standard Rubber; later joining Sierra Rubber before taking over the Patterson-Ballagh rubber laboratory.

Under Larkin's guidance Patterson-Ballagh now has one of the foremost rubber research laboratories in the West.

Larkin has achieved numerous outstanding successes in developing special rubber for various industries and will shortly announce the perfection of several new PBX special formulas designed especially for oil field use.

Specific tasks call for specific types of wire rope . . . but, regardless of construction, it must be tough and dependable.

That's why more and more men are relying on the stout steel muscles of Wickwire Rope.

Back of the durability and dependable performance of Wickwire Rope lies 126 years of specialization in the manufacture of wire and wire products. Every step—from ore to finished product—is handled in our own plants. Only the sound heart of the steel ingot is used for Wickwire Rope and every wire is drawn until it is accurate within a fraction of a thousandth of an inch.

Wickwire Rope is available in all sizes and constructions, both regular lay and WISSCOLAY *Pre*formed.

THIS FREE BOOK SHOWS HOW TO MAKE WIRE ROPE LAST LONGER

"Know Your Ropes" contains 82 pages of suggestions on proper selection, application and usage of wire rope. This easy-to-read, profusely illustrated manual can save you money. For your free copy write Wire Rope Sales Office, Wickwire Spencer Steel, Palmer, Massachusetts.

WICKWIRE ROPE

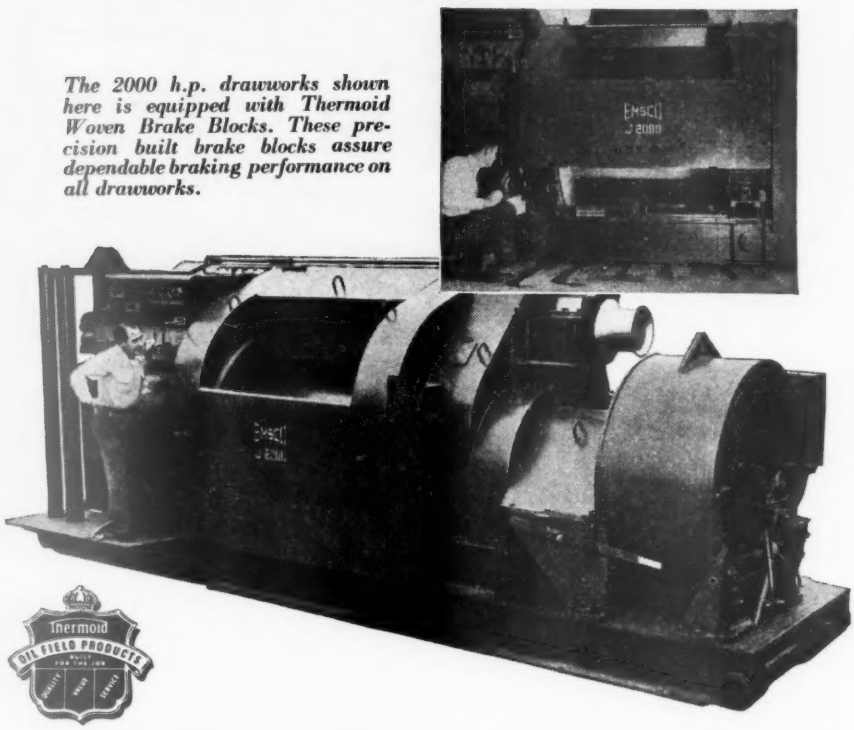
A PRODUCT OF WICKWIRE SPENCER STEEL DIVISION OF THE COLORADO FUEL AND IRON CORPORATION

WIRE ROPE SALES OFFICE AND PLANT—Palmer, Mass.
GENERAL OFFICE—361 Delaware Ave., Buffalo 2, N.Y.
SALES OFFICES—Abilene (Tex.) • Boston • Chattanooga
Chicago • Denver • Detroit • Philadelphia • Tulsa
Ft. Worth • Houston • Newport News • New York
PACIFIC COAST:—The California Wire Cloth Corp., Oakland 6, Cal.

CF&I

To Handle a Half Million Pounds of Pipe in a Four Mile Hole . . .

The 2000 h.p. drawworks shown here is equipped with Thermoid Woven Brake Blocks. These precision built brake blocks assure dependable braking performance on all drawworks.



This drawworks will have to "stand the gaff" of extreme loads in working a 20,000 ft. hole. And the load will ride the brake blocks a great deal of the time.

For such service, the manufacturer wisely chose Thermoid Woven Brake Blocks. Thermoid Blocks give positive braking action without chucking or chattering. They are accurately sized and cured to exact shape, so as to fit the flange snugly. They are furnished with an exclusive expander sleeve, insuring tight blocks and perfect braking action right down to the bolts.

When You Buy Brake Blocks for Replacement

Remember, Thermoid blocks are *Packaged In Sets* for the machine you want to reequip. The blocks are correctly formed and jig drilled at the factory, from the builders' specifications for your machine, then packed in cartons (enough blocks for one band in each carton) in such a manner that the preformed radius cannot change in shipment. Each box is marked with the name and number of the machine for which they are intended . . . there's no chance for error. When Thermoid Blocks are used, relining time is reduced to a matter of minutes.

Thermoid serves the world-wide Oil Industry through hundreds of supply stores that distribute the products listed below.

Rotary Brake Blocks • Woven Oil Field Brake Lining • Drill Pipe Protectors • V-Belts and Drives • "No Wip" Line Saver • "Powerflex" Pressure Seal Rotary Hose • Slush Pump Hose • Oil Country Belting • Stuffing Box Rings • Wire Line Turn Back • Flexible Discharge Unit Hose • All Types of Production Hose • Tubing Protectors.

Thermoid Products

Automotive • Industrial
Oil Field • Textile

Thermoid Company, Trenton, N. J., U. S. A.
Warehouses in Houston, Los Angeles, Wabash

G. L. Kothny succumbs

G. L. Kothny, vice president and general sales manager of the Sperry-Sun Well Surveying Company, Philadelphia, Pennsylvania, and prominent inventor of industrial equipment, died May 28. He was 66. His home was on West Valley Road, Strafford, Pennsylvania.

G. L. Kothny

Kothny had been with Sperry-Sun, a wholly-owned subsidiary of Sun Oil Company, since 1929.

He was born in Troppau, Czecho-Slovakia, and educated at the universities of Reichenberg and Prague.

Kothny contributed numerous articles to scientific journals and in 1920 received the Franklin Institute Medal of Merit as co-inventor of the Radojet Air Pump, which became standard equipment for ships.

During his long career as a designing engineer he served as consultant to industrial firms in several European countries.

Parts manager

George M. Conner, formerly assistant parts manager of the Diesel Engine Division of Stewart and Stevenson Services, 4516 Harrisburg, Houston, Texas, has been promoted to parts manager of the Houston plant, Joe Manning, manager of the firm, has announced.

G. M. Conner

Conner has been with Stewart and Stevenson Services for three years, having come from Texarkana, Texas, where he served as sales supervisor for the Dr. Pepper Bottling Company. Stewart and Stevenson Services have their headquarters in Houston, and branch offices in Dallas, Corpus Christi, Wichita Falls, and McAllen.

Brady promoted

W. J. Brady, local representative for Bethlehem Supply at Houston, Texas, has been promoted to district manager of the Southwest Texas District with headquarters at Corpus Christi. Jim, as Brady is known to his many friends, became affiliated with Bethlehem at Tulsa in 1939. He has served in various capacities with the company at Tulsa, Wichita Falls, Amarillo, and Houston. Prior to his connection with Bethlehem he had ten years' experience in the supply business.

W. J. Brady

Miner to U.O.P. board

Carl S. Miner has been elected to the board of directors of Universal Oil Products Company, Chicago.

A native of Iowa, Miner attended Coe College, Cedar Rapids, and the University of Chicago from which he graduated in 1903 with a B.S. degree in chemistry. Immediately afterwards he served as a research chemist for Corn Products Refining Company In 1906, he resigned to establish the Miner Laboratories. He continues to direct the activities of the company which he founded more than 40 years ago.

C. S. Miner

Miller is credited with many scientific achievements during his long association with the chemical profession. Listed in American Men of Science, his name is denoted by a star, which indicates that he is among the leading thousand scientists in the United States. In 1940 he was the recipient of a Modern Pioneer Award from the National Association of Manufacturers.

During the war, Miner was a consultant to the Rubber Survey Committee and a member of the Chemical Referee Board, Office of Production Research and Development, War Production Board.

FWD director

Robert A. Olen, general manager of The Four Wheel Drive Auto Company, Clintonville, Wisconsin, was elected a member of the board of directors at the regular monthly meeting May 20, to succeed Charles Hagen, deceased.

The elevation of Olen to directorship is another step in the company's program of vesting increased authority and responsibility in younger men in the company.

R. A. Olen

Olen started to work at FWD in 1924, working in the machine shop during school vacations. He operated screw machines, millers and grinders, and other production equipment in the factory, and worked in the payroll department. He became the first foreman of the derrick department.

After his graduation from Lawrence College, he worked in the sales department and the advertising department. He spent four and a half years in the field, selling in the states of California, Nevada, Utah, and New Jersey, and headed direct mail advertising. He was then promoted to the executive office, serving as secretary to the president and later as assistant general manager.

Olen was named general manager by the board of directors in 1944.

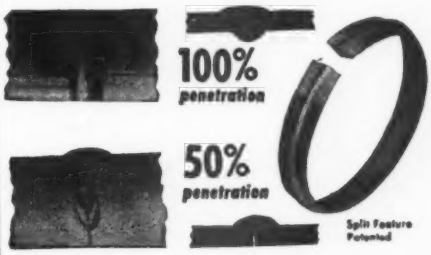
New Cameron wellheads highlight conferences

Sales and field service men of Cameron Iron Works met recently at the company's Houston headquarters to hold a three-day conference. It was devoted principally to the new line of forged steel casingheads, tubingheads, and christmas tree flow wings, which the company has developed.

The men in the picture are: Front row, left to right: Herbert Allen, Madden Works, Bill Collins, Geo. E. Myers, Carl R. Griffith, Raymond C. Buchanan; middle row: Sydney S. Raimer, Alford A. O'Connor, William Roy Davis, Ivey E. "Fox" Moses, Morey Zorgdrager, Xavier R. Showers, Atlee D. Cathey, Jack W. Harris, J. R. Jerabeck, Joseph A. Tennant, Jr., Carnie L. Potts, Frank H. Isaacks, Robt. F. Farmer, Edmond L. Lorehn, Ruric N. "Roy" Bean, H. G. "Jeff" Musolf, Homer E. Brown; top row: Richard W. Gustine, Adolph L. Scharck, Frank M. Allen, Robt. W. Gunsalus, Willie R. Price, Geo. N. Moughon, Douglas V. Clemons, Judson J. "Doc" McCann, Chas. W. Giraud.

with FEWER MAN HOURS and LIGHTER PIPE .. You get STRONGER Joints by using WEDGE Split CHILL RINGS

There is usually the better and more efficient way of doing most operations. Many Engineers have found that the use of WEDGE Chill Rings with the patented SPLIT Feature is the most efficient way of joining pipe—for refinery or



pipe lines. The joints are REINFORCED and are, therefore, the strongest part of the line. Because the joints are reinforced it is possible to use LIGHTER pipe. This reduces the cost of the pipe, shipping and handling. Great savings are assured by using WEDGE Chill Rings—why not investigate?

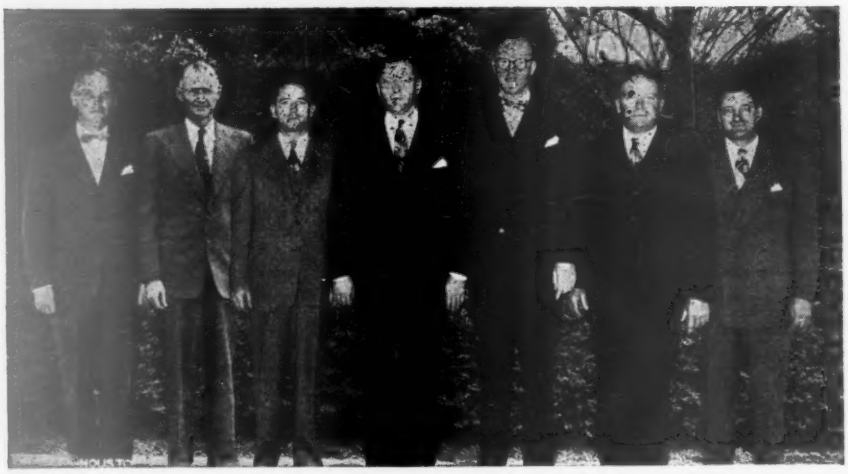
Write for Information

WEDGE PROTECTORS, INC.

3977 Jennings Road, Cleveland 9, Ohio

WEDGE Split CHILL RINGS SAVE MONEY

Oil Center Tool observes 20th anniversary



Officers and directors of Oil Center Tool Company, left to right: B. V. Fisher, A. J. Penick, J. E. Edwards, C. B. White, J. F. Maher, Fritz Richards, and J. E. Eckel.

Oil Center Tool Company, Houston, Texas, manufacturers of oil and gas well completion equipment, observes its twentieth anniversary this summer, according to A. J. Penick, chairman of the company's board of directors, in session recently to plan an anniversary celebration in August.

In tracing the growth of the company, Penick pointed out that the firm established in 1927 as a modest one-lathe machine shop, has grown steadily and now occupies the position of a major producer of essential tools for the world-wide petroleum industry.

Quebracho shortage

A shortage of Quebracho products used in drilling muds has been evident in recent months, according to H. R. Tisdale, vice president, American Dyewood Company, New York City. This shortage has occurred both in Argentina and in Paraguay due more or less to political conditions as well as a shortage in some of the primary raw materials, he says, and states further:

"The fact that Quebracho is arriving at irregular intervals and in smaller quantities than desired, has led oil drilling companies to find a substitute for the Quebracho, which has been used for many years. A satisfactory substitute seems to be the Mimosa or Wattle Extract produced from the Wattle tree, which is cultivated in South Africa. The tannin of Wattle or Mimosa Extract is a catechol type and therefore very similar to the chemical nature of the tannin contained in Quebracho. The Wattle Extract or Wattle Powder does not require any alkali to solubilize the catechol tannin. The Wattle type is perfectly soluble in hot water as well as cold water. The powdered material produced by the spray drying process is stable under conditions of high heat and humidity. It remains free flowing under similar conditions. It seems quite likely that Wattle Extract will prove of increasing importance in oil-drilling mud preparations."

To U.O.P. board

James M. Barker has been elected to the board of directors of Universal Oil Products Company, Chicago. Barker, who is a native of Pittsfield, Massachusetts, is a graduate of Massachusetts Institute of Technology, where he served as assistant professor from 1907 to 1909. He began his business career in 1909 as a draftsman and designer for the American Bridge Company.

J. M. Barker

In 1928 Barker became regional manager for Sears, Roebuck and Company at Philadelphia. Now a director of Sears, Roebuck and Company, Baker is chairman of the board of Allstate Insurance Company and Allstate Fire Insurance Company. He is also a director and voting trustee of the Chicago, Milwaukee, St. Paul and Pacific Railroad, and a director of Harris Trust and Savings Bank, Chicago. He is trustee of Northwestern University, a trustee of the American School of Prehistoric Research, and a life member, corporation, Massachusetts Institute of Technology.

"Oilwell" changes

Opening of a new store at Pauls Valley, Oklahoma, and several new personnel changes have been announced by Mark Barkhurst, manager of the Mid-Continent Division of Oil Well Supply Company, Dallas, Texas, U. S. Steel subsidiary.

Albert H. Mayo, with wide experience in gasoline plant constructoin and petroleum supply, has joined the company as district engineer, refinery sales, with headquarters in Tulsa, succeeding the late J. W. Koontz. Mayo received his

CHROME CLAD
THE BEST TAPES
FOR THE
OIL INDUSTRY

The Lufkin "Anchor" Chrome Clad Steel Tape is just what you need for general measuring work. It's durable—the chrome "life jacket" protects the sturdy line against cracking, chipping, and peeling. It's easy to read—jet black markings are recessed so they can't wear out. It's easy to handle — convenient size, smooth working. And it's accurate — made to superior Lufkin standards. Order the Lufkin "Anchor" through your supply house. For free catalog write THE LUFKIN RULE CO., SAGINAW, MICH., New York City.

LUFKIN FOR ACCURACY

degree in mechanical engineering at Carnegie Tech in 1922.

Roy F. Shaner, manager of the Wewoka, Oklahoma, store since November, 1945, has been transferred to Oklahoma City as assistant district engineer. Employed by Oil Well Supply Company May 18, 1936, he served at McPherson, Kansas, and Seminole, Oklahoma, stores before becoming Wewoka manager. Shaner is succeeded at Wewoka by Carey Lance. Lance became connected with "Oilwell" in July, 1940, and was with several Illinois stores before entering the U. S. Navy. After three years' service he rejoined the company in November, 1945, at Seminole, Oklahoma, where he remained until his new appointment.

Joe F. Daves, manager of the Madill, Oklahoma, store since December 1, 1941, has been named manager of the new Paul Valley store. Daves started with the company at Bristow, Oklahoma, January 15, 1927. Prior to becoming Madill manager he held positions in a number of stores in Oklahoma, Louisiana, Arkansas, and Canada. Leon G. Hutchinson, store man at Oklahoma City since joining "Oilwell" April 1, 1945, succeeds Daves as Madill store manager.

In Texas, Grover S. King, store manager at Abilene since November 1, 1946, has been appointed manager of the Greggton store, succeeding O. O. Beasley, resigned. King, who has also served with stores at Albany and Anson, is succeeded at Abilene by Stewart M. Miller of the Greggton store. Miller previously was connected with stores at Albany, Talco, and Eldorado, Arkansas.

Management changes

Giles C. Hoyt and General Levin H. Campbell, Jr., recently were elected executive vice presidents of International Harvester Company by its board of directors, John L. McCaffrey, president, announced.

At the same time, McCaffrey announced these other changes in the company's top management:

William E. Worth, formerly executive vice president, has retired after 27 years' service with the company.

Robert P. Messenger, formerly vice president in charge of the Farm Implement Division, becomes vice president in charge of Foreign Operations, succeeding Hoyt.

Ralph C. Archer, formerly vice president in charge of the Farm Tractor Division, becomes vice president in charge of the Farm Implement Division.

Michael J. Graham, formerly assistant to the vice president in charge of manufacturing, has been appointed general manager of the Farm Tractor Division and succeeds Archer as executive head of that division of the company.

Diesel school

In recognition of the extreme importance of providing the best possible service to owners of their products, the Detroit Diesel Engine Division has set up at its factory in Detroit a completely equipped school for training GM diesel mechanics in the operation and servicing of the Series 71 engine. Detroit Diesel distributors and dealers may, upon proper application, send their service personnel to the factory for a concentrated but thorough training course in basic diesel mechanics.

This course has been specifically designed to develop skill in the maintenance and repair of Series 71 engines and to create an understanding of operating requirements and trouble shooting procedure. Classes of 12 students are scheduled every two weeks depending upon the number of applications received for the course. By limiting the enrollment to small numbers, each student is guaranteed personalized instruction through the entire training period.

During the course, each trainee receives manuals and other technical information that is used as text material during the training period and which may be retained for reference purposes after leaving the school.

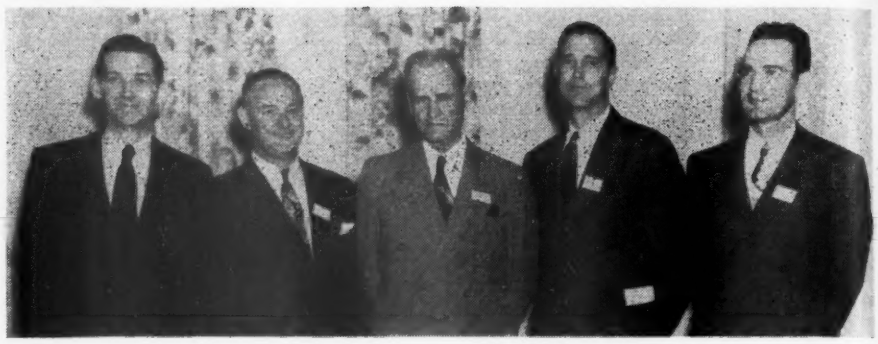
A second type of student that is now being trained in Detroit Diesel's service school is the factory employe of manufacturers who use the GM Diesel Series 71 engine in various types of contractor's equipment; shovels, cranes, welding sets, etc. These men, in groups of 12 to 18, are given a week's training in the things they are expected to know about the operation of the engine.

As soon as practicable, it is planned to offer mechanical training to Detroit Diesel distributors' sales personnel as well, it is announced.

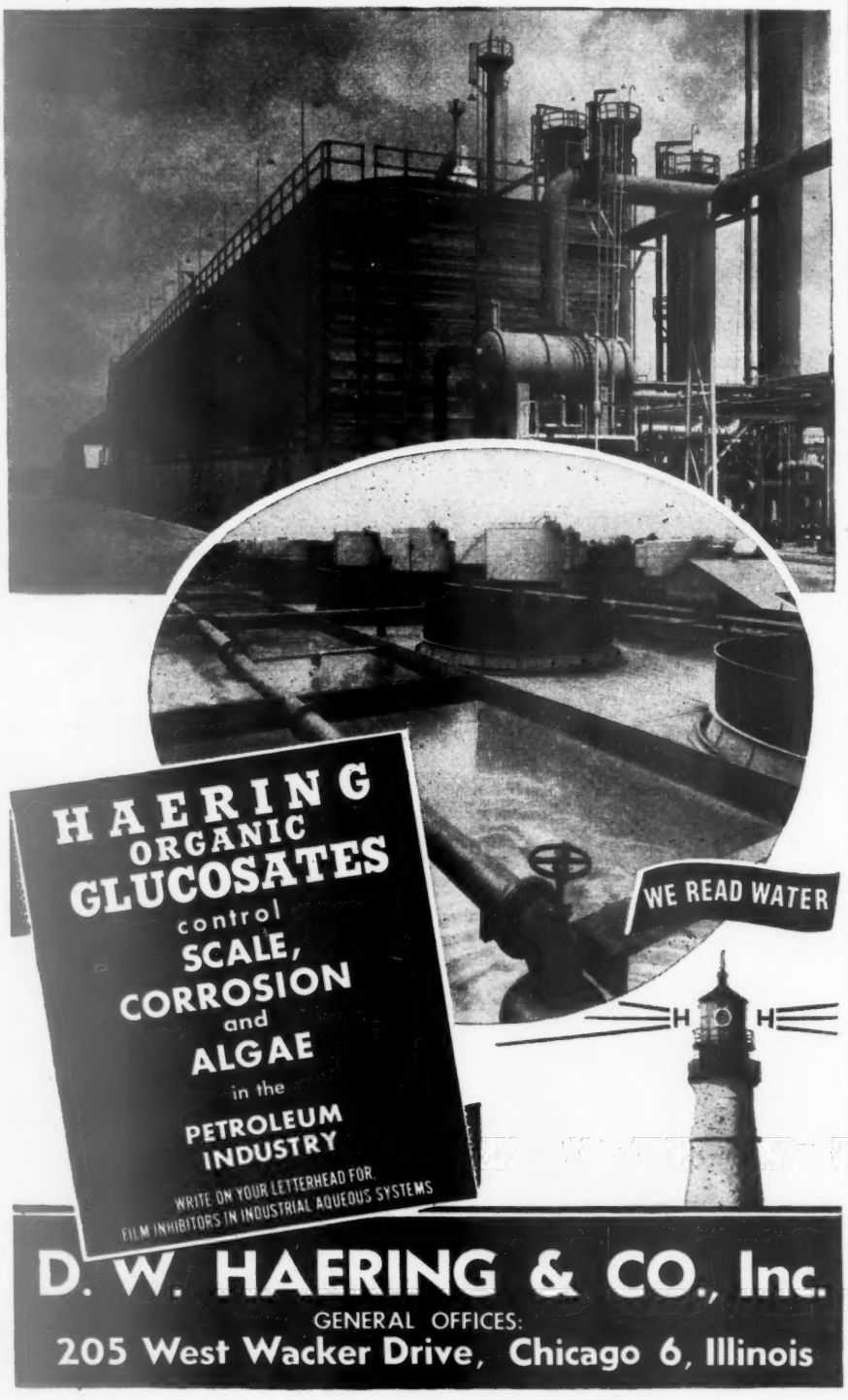
Install Them and Forget Them!
AMERICAN
RADIAL
Roller Bearings
AMERICAN RADIAL ROLLER BEARINGS are engineered to exacting standards that result in better performance and minimum maintenance.
Furnished in 5 styles, 6 S.A.E. series and 85 sizes. Special designs also available. Write.
AMERICAN
ROLLER BEARING CO.
420 Melwood Street
Pittsburgh, Pa.
Pacific Coast Office:
Los Angeles, Calif.

Mid-Continent Section A.P.I. officers

New officers elected at Spring Meeting in Amarillo of the Division of Production, Mid-Continent Section, American Petroleum Institute, are shown in the accompanying photograph. Left to right: W. L. Horner, chairman, Barnsdall Oil Company, Tulsa, Oklahoma; R. P. Moscrip, vice chairman for Kansas, Shell Oil Company, Inc., Wichita, Kansas; J. R. Phillips, vice chairman for Panhandle Area, independent operator, Borger, Texas; J. H. Field, vice chairman for Central Oklahoma, Sohio Petroleum Company, Oklahoma City, and J. H. Abernathy, secretary-treasurer, Big Chief Drilling Company, Oklahoma City.



New API officers elected at Amarillo at Spring Meeting.



C-B appointments

The appointment of J. F. Stevenson as assistant works manager of the Grove City, Pennsylvania, plant of The Cooper-Bessemer Corporation, to succeed the late M. A. Winland, who died recently, was announced by T. J. McMichan, works manager. Stevenson was formerly production manager of the company's Grove City plant.

Other recent Grove City promotions include W. A. Luli, who was named production manager; R. H. Bragg, assistant production manager; H. K. Stevenson, general superintendent, and W. W. Richards, chief planner.

All of the appointees have been connected with production and planning.

Hickman promoted

The Bethlehem Supply Company announces the promotion of A. E. "Chick" Hickman to district manager of the Texas Panhandle Area. "Chick" joined Bethlehem Supply in February, 1945, as store manager and field representative of the Pampa, Texas, store. Prior to his affiliation with Bethlehem Supply he was associated with the lumber industry in Kansas, Oklahoma, West Texas, and the Panhandle for 12 years and is thoroughly acquainted in the oil fraternity.

A. E. Hickman

R. B. Roark retires

R. B. Roark, vice president and area manager for the Shell Oil Company in Tulsa, Oklahoma, will retire July 1 due to ill health. Roark served with Shell for 29 years, advancing from instrument man to his present position. Roark is succeeded by W. A. Alexander.

Service awards

E. W. Saybolt and Company, Houston, Texas, recently awarded 25 year service certificates to W. H. Kea, E. J. O'Halloran, George E. Beyer, and posthumously to J. M. Bourgeois. C. J. Turner was awarded a 15-year certificate, and 10 other employes were given 10-year certificates.

Lahee appointed

Appointment of Dr. Frederic H. Lahee as geological and research counsellor of the production department of Sun Oil Company has been announced by Jno. G. Pew, vice president in charge of production.

Dr. F. H. Lahee

Dr. Lahee, chief geologist for Sun Oil Company since 1920, will be relieved of growing administrative detail in the Dallas division and will be available for consultation on all matters of production science throughout the company.

Simultaneously, appointment of Francis E. Heath as chief geologist of the Dallas division was announced by J. H. Pressley, manager of the Dallas division of the production department. Heath had been chief petroleum engineer and assistant chief geologist.

F. H. Heath

A. S. Rhea

Pressley also announced the appointment of A. S. Rhea as chief petroleum engineer of the Dallas division. Rhea had been assistant to Heath.

Adds to staff

The Guiberson Corporation, Dallas, Texas, manufacturer of oil field equipment, recently announced additions to its sales and service force in Oklahoma.

R. A. (Bob) Day has joined the company and will make his headquarters in Tulsa. He was previously a member of the sales department of Oil Well Supply Company in Tulsa, and prior to that

R. A. Day

N. H. Anderson

Illinois sales representative for Miller Sand Pump Company. Day began his career in the oil field equipment supply business as store manager for the National Supply Company in the Mid-Continent Area.

N. H. Anderson, for 12 years Guiberson sales and service representative, will continue in this capacity, making his headquarters in Oklahoma City.

Executive changes

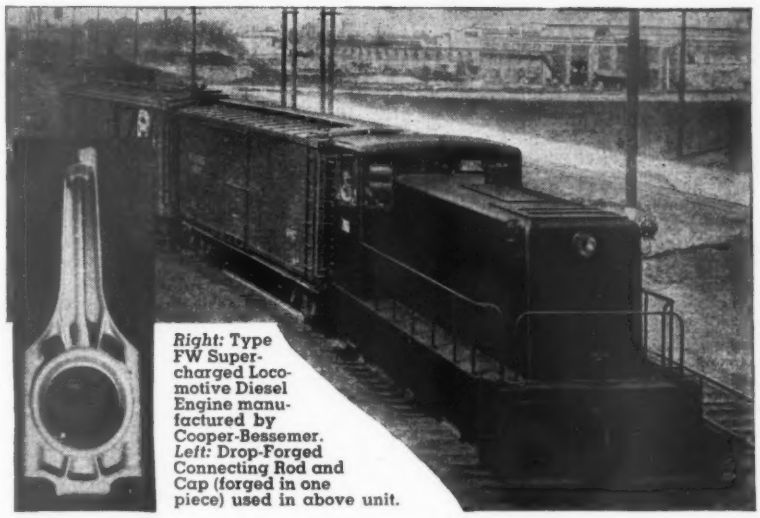
William A. Roberts and William C. Johnson have been appointed executive vice presidents, respectively, of the tractor and general machinery divisions of the Allis-Chalmers Manufacturing Company, it is announced by Walter Geist, president.

At the same time Geist announced two new vice presidents for the two divisions of the company. They are Marshal L. Noel, vice president and general sales manager for the tractor division, and J. L. Singleton, vice president and director of sales for the general machinery division.

Roberts formerly was vice president in charge of the tractor division, and Johnson was vice president in charge of the general machinery division. Noel formerly was general sales manager of the tractor division, and Singleton was manager of the general machinery division's district sales offices.

"This further development of the executive structure of the company," Geist said, "is necessary because the post-war expansion of all branches of our business requires more specialized control of our two major divisions."

Cooper-Bessemer Puts Power in the Pull



Right: Type FW Supercharged Locomotive Diesel Engine manufactured by Cooper-Bessemer. *Left:* Drop-Forged Connecting Rod and Cap (forged in one piece) used in above unit.

This 70-ton switch locomotive, equipped with a compact locomotive diesel engine is rated 660 H.P. at 1000 RPM . . . just another example of "Cooper-Bessemer at Work."

Harrisburg Steel Corporation furnishes Cooper-Bessemer with many of the intricate parts for the Locomotive Diesel (Connecting Rods, Caps, Rockers and Main Bearing Caps).

We are extremely proud to number Cooper-Bessemer among our long established customers. They are one of the oldest regular users of Harrisburg Steel Products . . . just another reason why Cooper-Bessemer excells wherever fine performance is in demand.

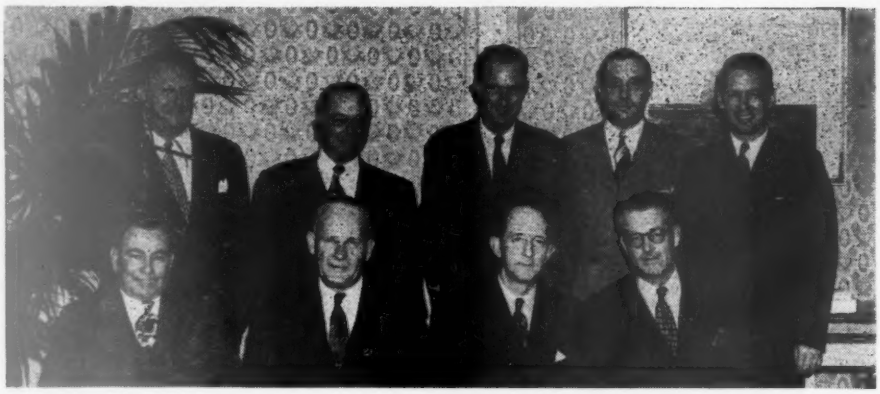
Drop Forgings by "Harrisburg"

insure greater strength, reduction in weight, lower machining cost and uniform physical properties. The elements of control over every phase of manufacture from steel to finished forging enables us to manufacture drop forgings from the simplest to the most intricate design.

Harrisburg Steel Corporation

Harrisburg • Pennsylvania

L. A. Nomads in regular monthly meeting



Nomads visitors: Seated, John Ramirez, H. D. Huskey, Edward T. Elliott, Robert R. Borncamp. Standing, A. C. Whitlen, Paul Hughes, H. M. Heath, Andre J. Demargne, Phillip Morris.

Los Angeles Nomads met at the Jonathan Club for their regular monthly meeting on May 14, and, with Bob Eiche presiding, enjoyed a program that didn't feature any after-dinner speaker, but had a fine substitute in the persons of Constable Les Keays and Lieut. Sewell Girggers of the Los Angeles County Sheriff's office, who gave an exhibition of marksmanship that was really the last word in shooting prowess.

After the dinner, Henry Pullman introduced the following foreign guests, without a mistake: Andre J. Demargne, SNPLM, Paris, France; Edward T. Elliott, Arabian-American Oil Company; Phillip Morris, Anglo-Egyptian Oil Company, Cairo, Egypt; John Ramirez, Arabian-American Oil Company: H. D. Huskey, Iraq Petroleum Company; Paul "Shorty" Hughes, Colpet, Colombia; A. C. Whitlen, Rex Company; Robert R. Borncamp, International Water Company, Paris, France, and H. M. Heath, Shell Oil Company, Ecuador.

Vice President Fred Ripley Jr., initiated Bernie Thompson into regular membership in an impressive little ceremony, after which Tommy Johnston, gave an interesting impromptu lecture on the duration of life insurance coverage. Then, in the absence of Lee Laird, Earle Boggess presented the master of ceremonies, Joe Schlarb, who in turn introduced the two marksmen, aforementioned. With pistols, revolvers, and machine guns, these gentlemen did everything but snip Tommy Johnston's suspenders. They knocked the ashes off his cigar, clipped the band off without touching the weed, and in general indicated that any time a representative of the Sheriff's department says, "Halt!"—it would be a right smart idea to halt.

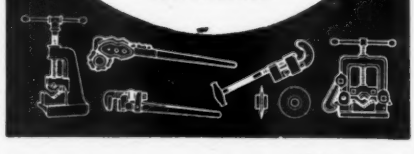
According to By Landis, who, with his assistant, Johnny Rife, is doing a swell secretarial job for the Los Angeles Nomads, the chapter, as of May 1, had 17 members, consisting of 106 regular, 26 associate, and 5 honorary members.

CHAIN TONGS

"ARMSTRONG BROS." Chain Tongs come in "Standard," "Reversible Jaw" and "Ideal" (V-jaw) types—in sizes for every need. Their drop-forged jaws have milled teeth, are hardened, tempered and tested for wearing qualities. They have heavy forged-in lugs that give extra bearing on the handles to which they are rigidly held by a large hardened steel bolt. The handles are forged and heat treated to the correct balance of stiffness and spring. Shackles are drop forged and chains proof-tested to ⅔ catalog strength (3,600 lbs. to 40,000 lbs.).

Write for Chain Tongs Circular

ARMSTRONG BROS. TOOL CO
331 N. Francisco Ave.,
Chicago 12
New York
San Francisco



JENSENS pump for LESS

Jensen Pumping Units backed by 27 years' experience—generally reduce pumping costs on all wells where sucker rod equipment is indicated.

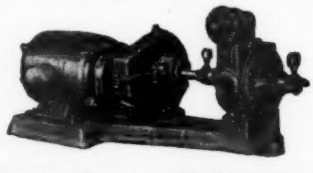
Sales and service of Jensen units are handled by reputable equipment dealers everywhere. They are always "on call."

JENSEN
BROTHERS MFG. CO.
Coffeyville, Kansas, U. S. A.
Export Office: 50 CHURCH STREET, NEW YORK CITY

PUMPS
for the
PETROLEUM
INDUSTRY

Write for Bulletin No. 102 which shows why and how

BLACKMER PUMPS
are SELF-ADJUSTING FOR WEAR



Gathering Pumps • Refinery Pumps
Bulk Station and Truck Pumps
Hand Pumps • Suction Line Strainers
Capacities to 750 GPM—Pressures to 300 psi

BLACKMER PUMP COMPANY
1980 Century Avenue Grand Rapids 9, Mich.

SERVING THE PETROLEUM INDUSTRY FOR 40 YEARS

Supervisory changes

The Continental Supply Company has announced two changes in the organization's supervisory personnel.

Charles Spitzfaden, Jr., has been made

C. Spitzfaden, Jr.

W. R. Gottshall

an assistant district manager in charge of Kansas operations, with headquarters in Wichita. He joined the Continental organization in 1937, serving as a machinery salesman in Oklahoma. His most recent position has been as assistant manager of machinery sales in the Tulsa area.

William R. Gottshall, until recently assistant manager of tubular sales for the Oklahoma-Kansas district, has been appointed as assistant district manager with headquarters in Oklahoma City. He will be in charge of the company's Oklahoma sub-district. Gottshall has been with Continental since 1936.

"Caterpillar" promotions

C. G. A. Rosen, director of research of Caterpillar Tractor Company, Peoria, Illinois, has announced the promotion of J. M. Davies to associate director of research in administrative charge of the department and R. C. Williams to assistant director of research in charge of tractor and earthmoving projects.

Davies joined the engineering department of "Caterpillar" in October, 1925, as a member of the engineering laboratory at the San Leandro, California, plant. In 1933, he moved to Peoria and organized the laboratory of the engineering department. When the research department was formed in 1942, he became assistant director of the department.

J. M. Davies

R. C. Williams

A University of Illinois graduate in mechanical engineering, Williams joined the company in November, 1932, as an engineering trainee. Upon completion of the course two years later, he became a member of the engineering laboratory and later served as a field engineer. In 1944, he worked as a project engineer before assuming duties as a staff engineer in 1945.

The present assistant directors of research, L. A. Blanc, W. L. H. Doyle, C. R. Maxwell, and C. R. Schad have been assigned additional duties.

Made parts manager

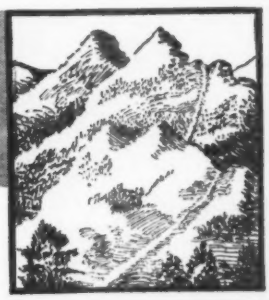
Reorganization of its engine and compressor parts division and the elevation of Edward S. Budd to the post of manager of the company's parts division, has been announced by Stanley E. Johnson, vice president and director of sales of The Cooper-Bessemer Corporation. Budd also carries the title of assistant secretary of the corporation.

Budd, who has served the company for 22 years, now assumes the responsibility of directing one of its fastest growing divisions of activity and one that has assumed vast importance in the nation's reconversion picture.

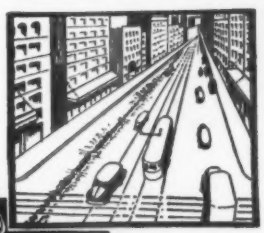
Cooper-Bessemer, like many engine manufacturers, devoted the major portion of its production efforts to the armed services and to critical industries during the recent war, Johnson declares, with the result that replacement parts for the thousands of gas engines, diesels, and compressors now in industrial usage are still acutely scarce. This year's volume of spare parts is expected by Johnson to account for nearly one-fifth of the company's total sales.

In his new post, Budd will be responsible for the establishment of credit policy, the organization of a standardized merchandising program, and delivery schedules of the parts department.

OVER MOUNTAINS
IN CONGESTED AREAS
THROUGH SWAMPS



HILL, HUBBELL
PIPE PROTECTION
FITS YOUR REQUIREMENTS



FACTORY APPLIED TO
YOUR SPECIFICATION

Your transmission and distribution lines are buried in soils of varying corrosive potentials.

Pipe in corrosive soils require engineered protection.

HILL, HUBBELL'S modern factory applied coating-and-wrapping is widely accepted by leading engineers, because of our exacting application of all specifications.

Hill, Hubbell and Company
Division of GENERAL PAINT CORPORATION
3091 MAYFIELD RD. CLEVELAND, OHIO.

WATER Wastes Fuel

when scale and corrosion clog boiler tubes. Equipment life is shortened, efficiency impaired.

Don't

put up with it. Regardless of water or operating conditions, with no need of water analyses.

SAND-BANUM

safely and automatically removes and prevents boiler scale and corrosion while your equipment operates.

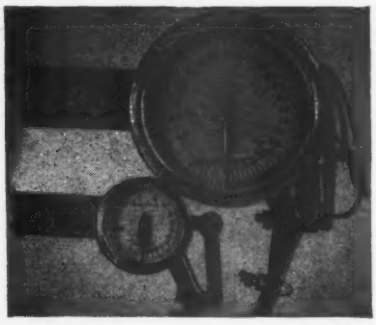
MAKE YOUR OWN TEST AND KNOW

Write for Details Today

"The Entirely Different Boiler and Engine Treatment"

AMERICAN SAND-BANUM COMPANY, Inc.
9 ROCKEFELLER PLAZA, NEW YORK CITY 20

LINE SCALES

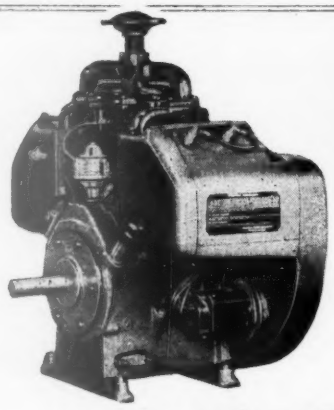


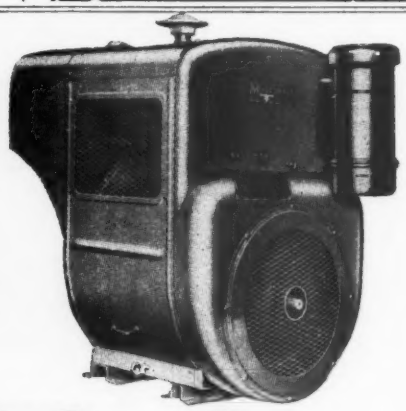
(Above) Super 500,000-lb. capacity, 14" dial. (Below) Packer Special, Capacity 40,000 lbs., 6" dial. 18 other models for every drilling, well servicing, or work-over need.

20 MODELS to choose from

With a LINE SCALE you know the pull on the line, and the weight on the bit in pounds. Repeated tests prove the accuracy and dependability of LINE SCALE readings under all working conditions . . . even in areas of rapid temperature changes.

LINE SCALE CO., Inc.
Box 4245 **Oklahoma City** Phone 6-1765
Gulf Coast Representative: Hiram Wheeler
Box 8043, Houston 4, Texas—J2-1107





Let this 20-Horse Team

Handle Your Heavy-Duty Power Jobs

Turning up 20.5 hp. at 2200 R.P.M. the Model VE-4 WISCONSIN Standard Air-Cooled Engine (left) and the Model VE-4 Complete Power Unit (right), can always be depended upon for continuous, heavy-duty operation in any kind of service, on any kind of equipment within their power range.

Positive, trouble-free AIR-COOLING; dynamically balanced crankshaft mounted on tapered roller bearings, *front* and *rear;* extra-long connecting rods; light weight pistons . . . these are features that you can bank on for top performance.

Specify Wisconsin Air-Cooled Engines for YOUR equipment . . . for most hp.-hours of service, at the lowest overall cost.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

Assistant chief engineer

John E. Slaughter, Jr., vice president of The Girdler Corporation, Louisville, Kentucky, in charge of the firm's Votator Division, has announced the appointment of H. W. Bevarly to the post of assistant chief engineer.

A native of Henry County, Kentucky, Bevarly joined Votator in 1929, after extensive experience as a machinist, mechanical draftsman, and refrigeration specialist. His practical approach to problems and his planning skill have made him one of Votator's key men. He has erected processing plants in England, Australia, and South America.

CHEMICAL ENGINEERS WANTED. Due to recent promotions we have openings for several chemical engineers in our 81 year old company processing Pennsylvania Grade Crude Oil. Give brief outline of education and experience. Your letter held in strictest confidence, with immediate reply assured. Address Box No. 67, c/o *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas.

DRILLING EQUIPMENT FOR SALE

1 Allis-Chalmers Generator, 350 Volts, 715 Amps, 1200 RPM, Serial No. 132379.
1 Allis-Chalmers Type EB120 D.C. Exciter, Shunt Wound, 15-KW, 120 Amps-125 Volts, 800 to 1200 RPM, Ser. No. 3196CK-120DEB-1-1.
1 Allis-Chalmers 300 H-P-350 Volts, 1000 RPM, 699 1 hour or 520 Cont. Svc. Drawworks Motor. Serial No. 132452.
1 Allis-Chalmers Type EM-2 Switchboard Complete (Ser. No. 3X5334) with Cutler-Hammer Control (Ser. No. B105711) with all Cables and (1) 1¼ HP DC Compound wound Blower Motor, 10 Amps, 125 Volts, 1800 RPM. Serial No. 9076MK-51DE1.

Priced at $15,000, this equipment can be seen at the Makin Drilling Company yard at Eunice or write Box 131, or phone 131, Hobbs, New Mexico.

SITUATIONS OPEN: Chemical Engineers with three to five years' experience in the operation of petroleum refining distillation units, thermal cracking units or catalytic cracking units for work as Technical Service representatives and Operators of commercial catalytic cracking plants. Kindly send details of experience and education. Snapshot (if available). Address Box No. 59, % *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas.

SEISMOGRAPH SUPERVISOR

Eastern Venezuela. Party chief experience, to act as Company representative overseeing labor, technical and operating phases of contract party work. Minimum salary $6000 plus living allowances. Foreign experience and Spanish helpful. Write
THE ATLANTIC REFINING CO.
Box 7258
Philadelphia 1, Pa.

FIELD GEOLOGIST

Foreign, aerial mapping, mainly reconnaissance but also indicated detail surveys. Approximately 5 years experience. Minimum salary $6000 plus allowances. Write to
THE ATLANTIC REFINING CO.
Room 900, Box 7258
Philadelphia 1, Pa.

ORIFICE METER CHART COMPUTING SERVICE

Our 20 years' experience in gas measurement to obtain ultimate results from orifice meter charts is available to large and small operators — *seven days a week.* Reduce chart reading expenses with this proven service combining accuracy, speed, and economy.

COMPUTATION BY INTEGRATOR

SPECIALIZED CHART AUDITING

FIELD AND SHOP OVERHAUL OF ORIFICE METERS

For detailed information write

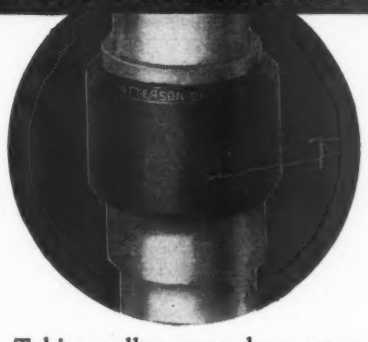
JOHN P. SQUIER

GAS MEASUREMENT ENGINEERING SERVICE

P. O. BOX 6100 DALLAS, TEXAS

"Best Bet Yet"

SAVE YOUR TUBING!



Tubing collars worn by contact with casing steal the profit out of pumping. Patterson-Ballagh Plastic Tubing Protectors prevent both collar and casing wear. Oil-proof, wear-resistant, insulating. They are pressed onto the collar under pressure and will not come off. Made in all sizes. End your tubing troubles. CALL in your Patterson-Ballagh man.

Specify "Rust Bat-gat"

PATTERSON-BALLAGH

A DIVISION OF BYRON JACKSON CO.

PLASTIC TUBING PROTECTORS

190 E. 65th Street, LOS ANGELES 1 — 931 Russ Bldg., SAN FRANCISCO 4

6247 Navigation Blvd., HOUSTON 11 — 808 Graybar Bldg., NEW YORK 17

Gets Goodrich award

In recognition of 20 years' association with The B. F. Goodrich Company, Republic Supply Company has been awarded a Service Award Plaque, according to John L. Collyer, president of The B. F. Goodrich Company, Akron, Ohio.

The award was presented to A. B. Judd of Republic Supply Company by

D. R. Anderson, B. F. Goodrich district manager, on May 14.

Republic Supply Company handles a complete line of industrial rubber products for the oil industry and first became associated with The B. F. Goodrich Company in 1927.

Ideco appoints

Announcements of new appointments to Ideco sales organization have been made by T. D. Collins, vice president, International Derrick and Equipment Company.

Fred Knieff has been appointed city representative in Dallas. Knieff will have his headquarters in the Ideco Building at 1315 Pacific Avenue. Fred Knieff joins Ideco from West Texas where he served as a supply company representative for eight years in Midland and Odessa. He holds a degree from Southern Methodist University.

Arthur H. Knight has been appointed machinery representative for Oklahoma and Kansas. Knight will make his headquarters in Ideeo offices in the Kennedy Building in Tulsa. Knight for eight years was division engineer on drilling machinery for one of the major manufacturers. He is a graduate of Michigan State.

P. M. Kovack has been appointed sales representative at Fort Worth. Kovack will have his headquarters in the Ideco offices at 1306 Commercial Standard Building. Kovack has been in the Mid-Continent Area for 18 years. He was sales manager for The American Manufacturing Company prior to joining Ideco.

Don Shaw has been appointed machinery sales engineer for Texas, Louisiana, and Mississippi. Shaw will have his offices in the Ideco Building, Dallas. He is a Louisiana State graduate.

Advanced

PEERLESS JET PUMPS

Economically Produce the Water You Require for Light Industrial Needs

CAPACITIES: 120 to 7500 Gals. per Hour. From well depths to 120 Feet.

The Peerless engineering achievement of designing and building more efficient pumps with fewer moving parts has again been most successfully applied in the advanced Peerless Jet Pumping System. The trouble-free Peerless Jet Pump principle ingeniously applies the natural force of gravity, plus a minimum of mechanical power, to lift water upward by pressure from the Jet and force it to a pressure tank by means of an impeller. There is no simpler pump principle now being utilized where water lift requirements are comparable. Peerless Jet Pumps are easy to understand, install, operate and maintain. Once the constant-pressure Jet Pump is in operation, adjustment or repair is rarely needed. Extremely compact in design. Double or single pipe systems available in sizes from ¼ to 3 H.P. Quietly supplies the water you require whether installed over the well or offset at a distance from the water source. Ideally applied to wells 2" inside diameter and larger for water supply requirements of light industry including ice and refrigeration plants, creameries, dairies, milk plants, institutions, hotel, laundries, municipalities, motel, country estates, schools, etc.

See The

PEERLESS

Water King

Unique in design and operation. For shallow well installation only.

Fully protected Under R. Moineau U. S. & Canadian patents.

For trouble-free simplicity of operation, this unique pump utilizes the same "magic" pumping element of the Peerless Hi-Lift Pump. Hard chrome pumping element wholly positioned and protected within pump base is highly resistant to abrasive and corrosive action. Assures a clean constant water supply. Requires a minimum of space and attention. 100% automatic. Easily installed over well or off-set.

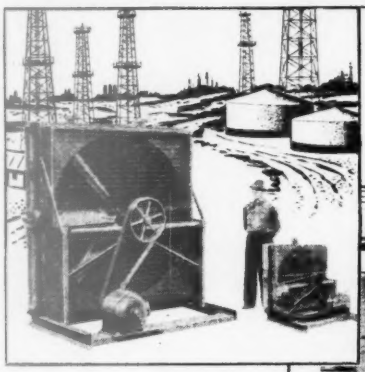
Write for Bulletins describing these two most efficient pumps.

PEERLESS PUMP DIVISION

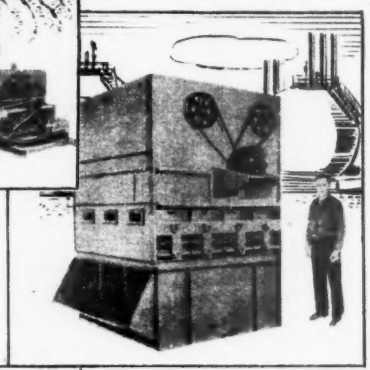
Food Machinery Corporation

Factories: Canton 6, Ohio • Quincy, Ill. • Los Angeles 31, Calif. District Offices: Canton 2, Ohio; Philadelphia: Suburban Square, Ardmore, Pa.; Atlanta: Rutland Bldg., Decatur, Ga.; Dallas 1, Texas.

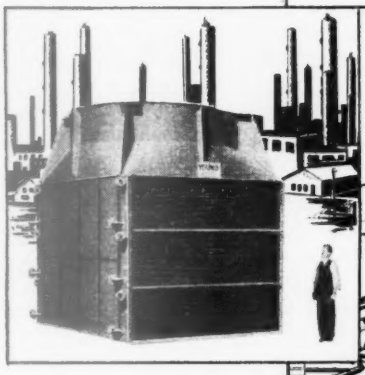
FOUR FAVORITES FOR COOLING
from Well to Refinery



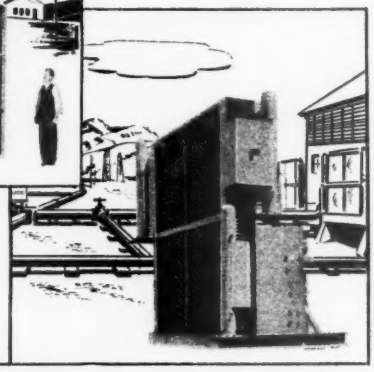
Jacket Water Coolers



Evaporative Coolers



Vertical Air Discharge Coolers



Atmospheric Gas Coolers

Wherever there are oil fields or refineries, you'll find Young Heat Transfer Products assigned to vital cooling tasks. In most every instance these applications are of a highly specialized nature and involved many hours of research and engineering on the part of Young factory and field men. When you are confronted with a problem in cooling, take it to the men whose job it is to produce efficient, economical results.

YOUNG

HEAT TRANSFER PRODUCTS

OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • HEAT EXCHANGERS
INTERCOOLERS • EVAPORATIVE COOLERS • ENGINE JACKET WATER COOLERS
GAS COOLERS • UNIT HEATERS • CONVECTORS • CONDENSERS • AIR
CONDITIONING UNITS • EVAPORATORS • HEATING COILS • COOLING COILS
AND A COMPLETE LINE OF AIRCRAFT HEAT TRANSFER EQUIPMENT

YOUNG RADIATOR CO. Dept. **RACINE, WIS., U.S.A.**

OIL FIELD DISTRIBUTORS
Mid-Continent Area: The Happy Company, Drawer 770, Tulsa 1, Oklahoma
West Coast Area: A. R. Flournoy Co., 5043 Santa Fe Ave., Los Angeles, Calif

In the spring an oilman's fancy lightly turns to what the oilman has been thinking about all winter, that is, the opening of fishing season, and so, it isn't to be wondered at that away back yonder in 1921, a group of enthusiastic Waltonians hied themselves to the San Jacinto Mountains bent on luring a succulent trout or two into their cooperative frying pan. The trip was so highly successful that it was forthwith instituted as an annual event, and the aggregation became known as the "Sons of May First."

The first trips into the mountain fastnesses were hazardous affairs, but the Sons of May First were then young, rugged, and vigorous. They enjoyed joggling over the twisty trails in their sputtering jalopies. It was exhilarating to lay their weary heads on moss-covered stones and sleep blissfully under the whispering pines. There was an ineffable flavor to a mess of beans, cooked on a grid by the side of the fast rushing South Fork, and coffee brewed in the great outdoors was nectar to these young woodland sprites. Perhaps most important of all was the fact that in these early days, the fish actually outnumbered the fishermen, so that occasionally one caught a trout that was fully grown.

In due course, the rusticity was rubbed off the mountains. The once rugged anglers were almost forced to dress in tuxedos for their fishing forays. The rude camps were transformed into modern cabins, with doors, windows, inside plumbing, feather mattresses, white sheets, bathtubs, and even electricity. Coincidentally, the joints of the fishers began to creak, their chests slipped lower, and fishing rods were traded for golf clubs. They began to bring in chefs, maitres d'hotel, and kitchen gentry, to do their cooking while they waddled precariously through nine holes of a game remotely resembling golf. Finally, even that became too arduous. The Sons of May First deserted the links, and took avidly to penny ante, and other similar species of indoor indolence.

Today, their gathering place at Idylwild has acquired the aristocratic name of "Mactechelwood," derived from the names of the three cabin owners—Archie MacDonald, "Teck" Tecklenborg, and Elwood Jones. To this hospitable retreat the members are carried every year in glittering limousines, driven by chauffeurs. When they arrive, *punkah wallahs* fan their fevered brows, as they sip the flowing cup and reminisce about the good old days when they used to enjoy moving about like the common people. They play weird games with such colorful names as "Spit in the Sink," "Seven Card Monte," and "I'll Have Mine Straight," and when the evening is far sped, they sing tuneful ballads of their own composing, to the accompaniment of strumming guitars and other noises laughingly called "music."

The Big Bahoo of this settlement, to whom all lesser braves must kowtow, is Elwood Jones, of Stockham Pipe and Fittings Company. He has long ruled the teepees with firmness and fairness, and none has dared to challenge his reign or right. As we write, he is in the throes of home building and when last heard of was out being measured for a breakfast nook. Among the older warriors who constitute the council of the Big Bahoo are Archie MacDonald of MacDonald and Burns, prince of fishermen and golfers, and so inordinately fond of gin rummy that he has even been known to play it without the gin; Jim Simpson of Kramer and Kramer, a man as meticulous in the use of the King's English as is an Aberdonian in the use of the Queen's scotch; Jim Barr, Pressed Steel Tank Company, inventor of the ambush scale that lies in weight for fishermen; Oliver Spradling, Central Tube Company, authority on poker work and other decorative arts, particularly those in which one is required to decorate the mahogany; Teck Tecklenborg, owner of one of the Idylwild cabins in which the group disports, and an angler who definitely knows all the angles; Jim MacDonald, historian of the organization and divot lofter extraordinary. He once put eight golf balls under a setting hen and hatched

out seven birdies and an eagle; and last but by no means least of this select coterie—Holly Hayter, Tide Water Associated P. A., who, when he first heard that modern drilling technique could straighten out the most crooked hole, sent a crew up to Idylwild to straighten the 7th hole on the local golf course.

The membership was later expanded by the inclusion of such outstanding citizens as Lew Smith, now living in the lap of luxury at Bakersfield, and doing most of his camping in the lobby of the El Tejon; Charlie Schneider, the well known Bay City horticulturalist who, when he could no longer play golf, took to gardening, which is the same thing only deeper; Bill Ackerman, another foster child of the Flying A who, generally speaking, is generally speaking. Bill is the lad who tried to get the Fish and Game Commission to put an R in every month in order to increase the sale of oysters; Bobby Burns, the other half of MacDonald and Burns, and a rabid shutter bug. He advises that when you photograph an oil man, you take a panoramic view, then you will be sure to get the ears in; also in this batch is Charlie Napier, who has been golfing for many years, but didn't get his first birdie until dove hunting season opened last fall. Practically all these are Tide Water Associated men, and two very fine fellows who originally joined up with this batch, Joe Weston and Jim Jones, have since passed away.

The latest recruits are Hugh Glen of Emsco, who did such a fine job of hosting the PESA convention at San Francisco, and whose favorite pastime we are told, is waking people up when they are sleeping soundly, recalling the Long Beach lad who walked in his sleep one night and was mistaken for a pumper working graveyard tour; Harold Howard of Howard Supply, whose hobby is to take a golf ball into a sand trap and beat all around it with a golf club; Bill Beck, General Petroleum impresario and a leading exponent of bridge—he says that for the nonce his game is deteriorating because of a rubber shortage; Joe Aderhold, Allied Supply Company, and his amazing story of the smart rabbit that lived on the fairway at Wilshire Country Club so it wouldn't get hit with a golf ball! Zeb Terry, lands and leasing consultant and big league shortstop—took to baseball, they say, in the hope that he might see Sally Rand among the fans; Bill Moeller, Southern California Gas Company, ukelele virtuoso—he chose this instrument because no one can tell whether it is in tune or not, although it is a safe bet that it is not. Whenever Bill asks the members, "Shall I play something for you?" they invariably reply, "Yes, ice hockey." Completing the roster is Les Wiggins, formerly with Youngstown, now in his own trucking business. Until he actually got into the business, Les thought the Mack Trucks were a Scotch family.

There you have the lowdown on one of our most exclusive organizations. For 26 years, the Big Bahoo and his aggregation of oilmen and equipment suppliers, have met annually in anything but solemn conclave, and together they have played the hours away, finding in their association congeniality and friendship that have grown stronger and stronger with every passing year. Nothing is permitted to interfere with that date—May 1. There is no need to send out notices or reminders to the members. Every Son of May First will be there if he can possibly make it, and nothing but a national catastrophe would impel him to cancel that unwritten rendezvous with the gang.

●

Diverging here, we spent an interesting evening in the home of Wesley Cunningham recently, and in case you haven't heard, the G. P. exec has the finest collection of color slides we have seen in a long time. There are dozens of gorgeous mountain scenes, sunsets, and sunrises, in natural color, all taken by the gentleman himself, and displayed very ingeniously with the aid of a remote control from the kitchen to the front room. The projector is set in the kitchen, and the lecturer signals the changes without the audience being the least bit conscious of the synchronization, although his comments all fit so nicely into the scheme, they ought to be suspicious of some sort of collusion. Incidentally, in the audience, we noted Dave Kilgour, secretary of Western Oil and Gas Association; Bryce Gillespie, who buys the oats for the Flying Horse; Alex Grant of Western Pipe and Steel; and an interesting gentleman, Willie Lairmount, erstwhile Standard Oiler, Shakespearian actor, and father-in-law of Ed Bedford, who has hired many a field worker for Western Gulf's foreign operations.

Add one, two or three channels to your present copper pair *without* the expense of additional lines. The Lynch Carrier System provides additional circuits at a small fraction of new line cost.

The Lynch Carrier System is the newest and most advanced equipment of its kind. Its installation is simple. Standard tubes and fully automatic operation make maintenance costs practically negligible.

Extensive service with major railroads, independent telephone and oil companies has proven the economy and workability of Lynch Carrier Systems.

SIMPLE, EFFICIENT, MODERN CARRIER EQUIPMENT

Easy to Install • Fully Automatic
Low upkeep costs • Low first cost, too

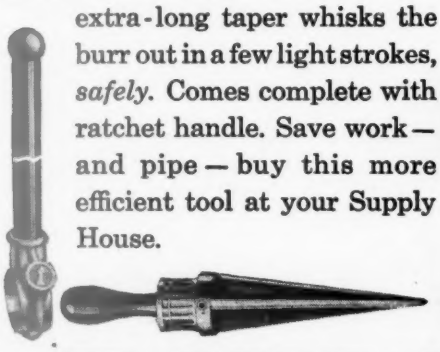
Example:
250 miles new copper pair =$50,000
Model 2 LYNCH Carrier Circuit = 2,400
SAVED by using LYNCH System =$47,600

SEND COMPLETE TECHNICAL DATA OF EXISTING CIRCUIT FOR QUOTATION

LYNCH *Carrier Systems*
3 EXTRA VOICE CHANNELS OVER ONE PAIR COPPER WIRES
F. W. LYNCH CO. • 44 Natoma St • SAN FRANCISCO • SUtter 3790

Extra-long-taper
RIDGID
takes work and risk
out of pipe reaming

● No thinning of pipe or conduit, no flaring or splitting it, even when you ream it extra fast—as this RIDGID encourages you to do. That extra-long taper whisks the burr out in a few light strokes, *safely*. Comes complete with ratchet handle. Save work—and pipe—buy this more efficient tool at your Supply House.



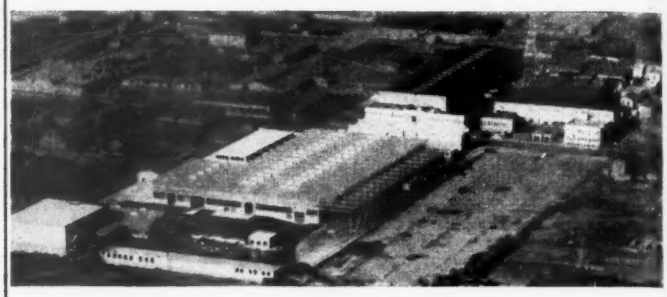
Reamer unit sold alone for use in RIDGID *No. 00R Ratchet Threader handle.*

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

New Byron Jackson plant

Completed recently and now occupied, is a new plant addition of the Byron Jackson Pump Division covering approximately eight acres on the south side of Vernon Avenue, Vernon, California. It supplants the present buildings on Slauson Avenue in Huntington Park, occupied since 1920.

Erected at a cost of over $1,500,000 and begun in January, 1946, the new addition includes an administration building,



and provides for machine shops, stock room and warehouse, shop cafeteria, service and pattern shops, truck shed, garage and maintenance, and oil and paint storage.

The plant and shop structures were designed by Ellis Wing Taylor, of the firm Edward Cray Taylor and Ellis Wing Taylor, and the office building by Albert B. Gardner of Los Angeles. The C. L. Peck Company, construction firm, built the plant. All phases of the building operations were under the direction of Floyd C. Merritt, vice president of the Oil Tool Division.

"The new plant," said E. S. Dulin, president of Byron Jackson, "is one of the most modern and well equipped, and will result in the most efficient and economical operation."

Rapid service assured

Rapid service at both ends! The Mid-Continent Cummins Export Corporation is shipping this specially equipped jeep station wagon to Earl G. Ellis, its export service manager in Caracas, Venezuela. Its purpose is to insure prompt delivery of Cummins diesel engine parts at the South American end. Urgently needed parts, shipped air express, will be picked up at

the airport the moment they arrive and rushed to the customer. Standing at the left is George Stevens, Southwestern regional export representative for Cummins Engine Company. At the right, with American Airlines hostesses is J. E. Everroad, vice president and general manager of Cummins at Fort Worth.

The salutation painted on the body, which translated means "greetings from your friends," carries out the spirit of cooperation between Latin America and the United States. The jeep's special equipment, installed at the Fort Worth diesel service shop, includes a winch with a 150-ft cable that can be operated by one man from inside the cab, reserve gas tanks, screens, a focusing spotlight, heater, fire extinguisher, digging tools, water and oil cans, chains, a large, complete first-aid kit, flares, Airosol bombs, and adjustable seats that can be moved to make enough room for a full length air mattress.

• **Rinehart's Yearbook, 1947,** *compiled by staff members of Rinehart's Oil Report under the supervision of C. J. Kessler. Published by Rinehart Oil News Company, Daniel Building, Tulsa, Oklahoma. Price, $10.*

Covering 22 states, this volume is an annual review of factual matter and statistics in oil production. With thoroughness and clarity, a picture of oil development in 1946 is presented. New formation discoveries are listed by counties with all pertinent information available in a few lines. New gas discoveries and new extensions are also incorporated in this compilation of facts. Also contained are many maps for visual reference.

Various sections in the yearbook combine one or more states and each section is preceded by a review of the state's development, principal leasing, outstanding finds, and probable fields of future significance. Cumulative production of different fields and wells is listed.

• **The Midwest Oil Register, 1947.** *Published by C. L. Cooper, P. O. Box 892, Tulsa, Oklahoma. Pages, 185. Price, $10.*

Operating personnel are listed in this Annual Register. Personnel of refineries, natural gasoline, and cycling plants operating in the United States, Latin America, and Canada have been checked and listed. The book is divided into the three fields of operation and further divided by countries, with an alphabetical listing of companies for ready reference. A ruled section is included for adding new companies and new officials that may come to your attention.

Other directories published by this company cover the producers and drilling contractors, Latin America countries, pipe line personnel in the United States and Canada. Handy books for men in any division.

Walter Geist re-elected

Walter Geist has been elected for his sixth term as president of the Allis-Chalmers Manufacturing Company. As all directors and officers of the firm were re-elected at the annual meeting of the stockholders and the board of directors.

The directors elected by the stockholders are W. C. Buchanan, Geist, Walter Kasten, Alfred J. Kieckhefer, and Louis Quarles, all of Milwaukee; Arthur W. Butler, New York, New York; John H. Collier and James D. Cunningham, Chicago, Illinois; Ernst Mahler, Neenah, Wisconsin, and Leigh Willard, Cleveland, Ohio.

In addition to Geist, the officers elected by the board of directors are J. A. Keogh, vice president and comptroller; H. W. Story, vice president and general attorney; W. E. Hawkinson, secretary and treasurer; E. H. Brown, vice president in charge of engineering development; W. C. Johnson, vice president in charge of the general machinery division; W. A. Roberts, vice president in charge of the tractor division, and James M. White, vice president in charge of manufacturing.

Other officers chosen by the board are J. F. Ryan, assistant secretary and assistant treasurer; A. F. Rolf, New York, assistant secretary; C. P. Allendorf, assistant comptroller; N. D. Johnson, assistant secretary, and G. F. Langenohl, assistant treasurer.

Harper heads Franklin Supply

The annual shareholders meeting of Franklin Supply Company, was held in the general offices at Chicago, Illinois, May 16. Stanley Martin, Glenview, Illinois; Roy Wood, Hammond, Indiana; Lawrence Harper, Mt. Pleasant, Michigan; Leland H. Strouse, Evansville, Indiana, and Jene Harper, Glenview, Illinois, were elected directors for the ensuing year. Officers elected by the directors were: Jene Harper, president; Stanley Martin, vice president; Albert J. Mitchell, treasurer, and Jean Harper, secretary.

Fast, efficient little

RIDGID Nos. 00R and 111R

for threading ⅛" to 1¼" pipe

● No slow complicated get-ready with these extra-handy small RIDGID threaders. You snap the die heads in easily from either side—can't fall out. You need no special dies for close-to-wall threads. Clean accurate threads always from heat-treated tool-steel dies. No. 00R, ⅛" to 1" —No. 111R, ⅛" to 1¼". Ask for these efficient durable threaders at your Supply House.

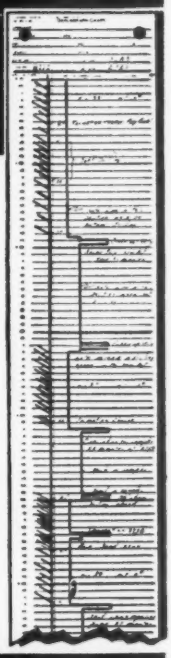
Handy free carrier for any group of sizes.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

GEOLOGRAPH
gives you a dependable DRILLING RECORD



DOWN TIME
connections, trips, repairs

DRILLING TIME
minutes per foot, and feet per hour

Formation Changes
as you drill

TOTAL DEPTH
at all times!

Good enough for the largest; reasonable enough for the small operator.

Write for details now.

"TIME WILL TELL"

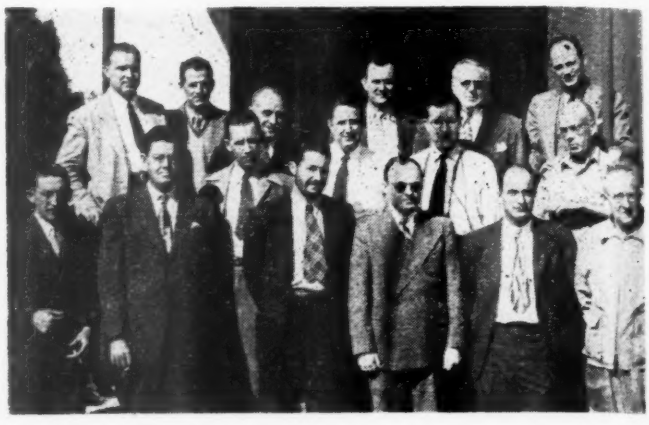
THE GEOLOGRAPH CO.

25 North Western — Oklahoma City 4, Oklahoma

Franks staff meeting

The Franks Manufacturing Corporation's sales and service executives and branch office managers posed for the photographer at the Franks Tulsa plant following a staff sales meeting the first week in June.

The meeting, the first annual postwar gathering of the expanded force, was held coincidental with the announcement



that Franks portable servicing units and rotary rigs will be sold through supply stores, except export and in California, beginning June 1.

Those in the photograph are, left to right in the back row, Clair Simmons, L. E. Ferguson, M. G. Scott, S. E. Corry, Carl White, Jr., president, and R. E. Kirberger, sales manager. Center row, Albert Hastings, V. K. Chapman, Joe Byrd, and A. J. Rogers. Front row, Vern Alley, Doug Lawrence, Tommy Knoblock, Leslie Brooks of Brooks-Keefe Advertising Agency, advertising counsel for the firm, Ken Lamer, and Mike Pallein.

Not shown in the photograph are George Lewis, John Howard, Don Turner, and John Leyh.

One of the strongest selling statements that can be made regarding any engine-powered equipment is this:

"It's Powered with a FORD-BUILT ENGINE!"

Engines available through district sales offices of Ford Motor Company or through Ford Dealers. Universal Ford Service always available everywhere.

Ford

FOURS · SIXES · V-EIGHTS

Write For Latest Industrial Literature

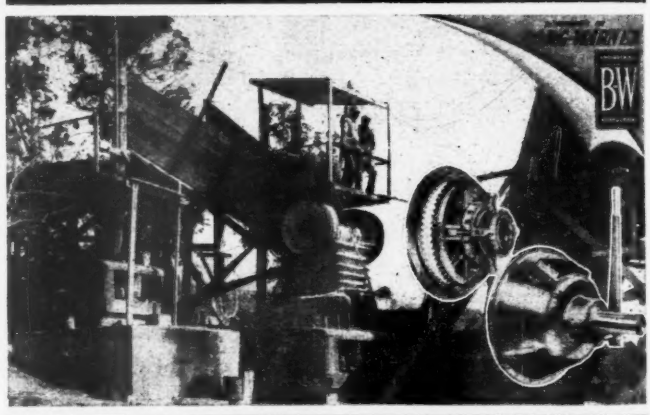
Address:

FORD MOTOR COMPANY

Industrial and Marine Engine Department

3505 SCHAEFER ROAD · DEARBORN, MICHIGAN

ROCKFORD



POWER TAKE-OFFS

SELF CONTAINED UNIT
WIDE RANGE OF SIZES
CONSERVATIVE RATING
ROLLER BEARINGS *
FINE ADJUSTMENT
ACCURATE BALANCE
S.A.E. DIMENSIONS

* ROCKFORD POWER TAKE-OFFS are equipped with roller bearings of ample proportions to carry the loads to be placed upon them. Provision is made for adjusting the tapered roller bearings that support the shaft. These and the clutch release bearing can be lubricated from outside the housing.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER

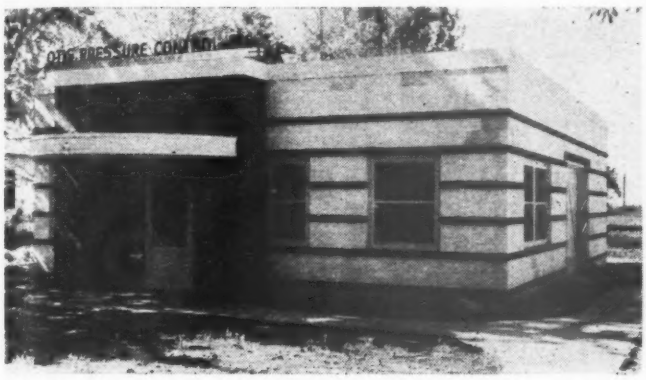
1303 Eighteenth Avenue, Rockford, Illinois, U.S.A.

New office and equipment depot

E. A. Kelley

H. C. Otis, president, Otis Pressure Control Inc., has announced the completion of a new office building and warehouse in New Iberia, Louisiana, which will considerably broaden the company's range of service and supply to the southern part of that state. Formerly, the nearest Otis warehouse and equipment depot was at Houston.

The new facilities will be under the management of E. A. Kelley, division superintendent, and will enable Otis engineers and field personnel to maintain a rapid service of installing Otis sub-surface controls, running and pulling tubing under pressure, and tubing corrosion surveys.



Otis office and warehouse at New Iberia.

Waldrip adds to staff

James Moon and B. P. Bayliss, formerly with Western Oil Tool and Engineering Company, and Dave Smith, formerly with Western Gear Works, have recently joined the staff of Waldrip Engineering Company, Hollydale, California.

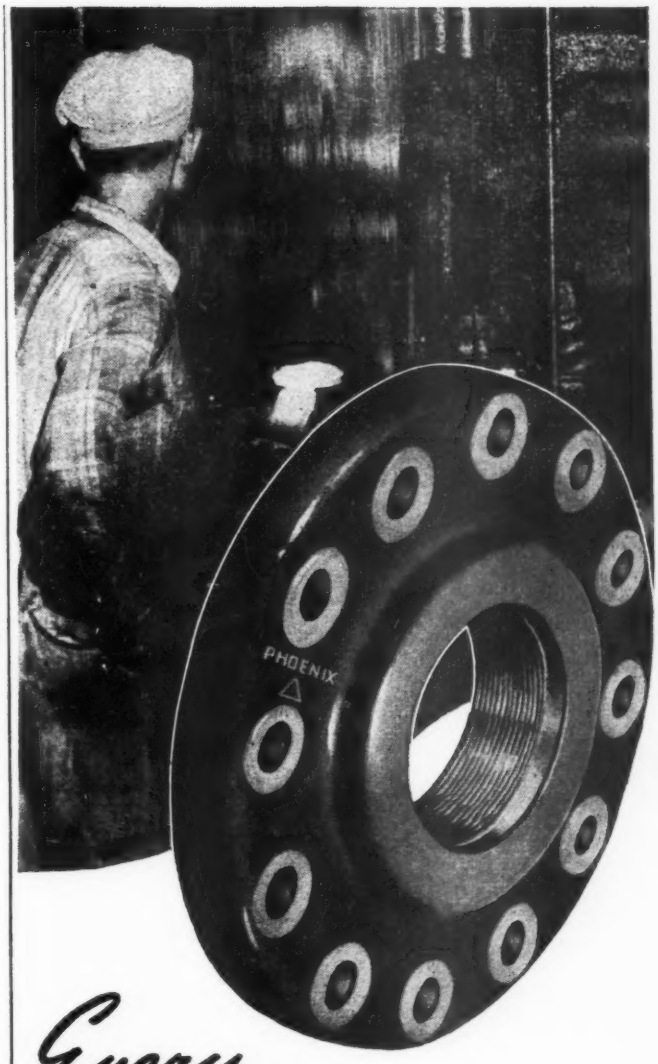
James Moon is a graduate of the University of Wichita with a B. A. degree in aeronautical engineering. From 1929 to 1931 he was in the design department of the Curtis Wright Airplane Company of Wichita, Kansas; from 1933 to 1936 was a design engineer with Cardwell Manufacturing Company; 1936 and 1937 with Boeing Aircraft Company as design engineer; 1938 to 1941 design engineer with Franks Manufacturing Company; associated for a short time with Hillman-Kelley as chief engineer; later operated as an oil-field consulting engineer and became president of Western Oil Tool and Engineering Company.

B. F. Bayliss is a graduate mechanical engineer of Ohio State University and is a member of the American Society of Mechanical Engineers. From 1938 to 1941 he was an engineer in the mechanical engineering department of the Shell Oil Company in the Mid-Continent and specialized in the development of portable "slim-hole" exploratory oil-well drilling units. During the war he became a lieutenant colonel in the 4th Armored Division Artillery Service in the United States and abroad. From 1945 he was vice president of Western Oil Tool and Engineering Company.

Dave Smith was educated in California technical schools where he graduated in electrical and mechanical engineering. In 1915 he joined the engineering staff of The National Supply Company. From 1924 to 1945 he was in the engineering department of Emsco Derrick and Equipment Company and was chief engineer of the Emsco Houston plant for a brief period. From 1945 to 1947 he was an oil-field engineer with Western Gear Works, and in January 1947 joined Waldrip Engineering Company. Smith has a number of important oil field equipment patents to his credit.

Reprint available

"Petroleum as a Source of Organic Chemicals," by C. A. Rager, is the title of an article reprinted from *Domestic Commerce*, a U. S. Department of Commerce periodical. The reprint is being made available to the public.



Every

PHOENIX FLANGE

is precision drop-forged

From raw billet to finished product, Phoenix Flanges are forged by men who know precision work. That's why Phoenix Flanges always fill your needs exactly. That's why they always meet ASA requirements and ASME and ASTM specifications.

The mild steel in these flanges is readily machined and welded . . . yet drop-forging imparts a toughness that means long service under any conditions.

Get your copy of the Phoenix Flange Catalog today. It shows the complete line.

PHOENIX Drop Forged FLANGES

PHOENIX MANUFACTURING COMPANY

Joliet, Illinois — Catasauqua, Pa.

ADVERTISERS *index*

A

Acme Fishing Tool Co. 210
Allis-Chalmers 74
American Chain and Cable Co., Inc. Inside Back Cover
American Cyanamid Company, Industrial Chemicals Division 175
American Dyewood Co. 208
American Iron & Machine Works Co. Back Cover
American Meter Co., Inc. 71
American Roller Bearing Co. 221
American Sand-Banum Co. 226
Armstrong Bros. Tool Co. 224

B

Baash-Ross Tool Co. 123
Baker Oil Tools, Inc. 209
Baldwin Locomotive Works 112
Baroid Sales Division 102
Bethlehem Supply Company 5
Blackmer Pump Company 224
Black, Sivalls & Bryson 151
Bowser, Inc. 215
Brewster Company, Inc. 165
Brown Engineering Company 176
Brown & Root, Inc. 15

C

Cameron Iron Works, Inc. 81
Cardwell Manufacturing Company, Inc. 54-55
Cavins Co., The 176
Chain Belt Company 107
Chapman Valve Manufacturing Co. 130
Chicago Bridge & Iron Co. Inside Front Cover
Chiksan Company 211
Continental Motors Corp. 29
Continental Supply Co. 205
Cook, C. Lee., Manufacturing Co. 23
Core Laboratories, Inc. 125
Crane Co. 26
Cummins Engine Co. 181

D

Dean Bros. Pumps, Inc. 167
Detroit Diesel Engine Division, General Motors Corp. 4
Dowell Incorporated 21
Dresser Industries 2, 28

E

Engineers & Fabricators, Inc. 194
Ensign Carburetor Co. 148

F

Fluor Corporation, Ltd. 37
Ford Motor Co. 232
Four Wheel Drive Auto Co. 185
Foxboro Company 202

G

Gardner-Denver Co. 31
Gaso Pump & Burner Mfg. Co. 38
General American Transportation Corp., Plate & Welding Div. 133
General American Transportation Corp., Wiggins Seal Div. 33
General Paint Corp. 225
Geolograph Co., The 232
Globe Oil Tools Company 127-128
Griscom-Russell Co. 198
Gulf Oil Corporation 63

H

Haering, D. W., & Co. 222
Halliburton Oil Well Cementing Company Front Cover
Harrisburg Steel Corporation 223
Hazard Wire Rope Div., American Chain & Cable Co., Inc. Inside Back Cover
Hercules Tool Co. 212
Hill, Hubbell & Co. Div., General Paint Corp. 225
Houdry Process Corp. 56
Hughes Tool Co. 83
Hunt Tool Co. 76-77

J

Jensen Bros. Mfg. Co. 224
Jerguson Gage & Valve Company 206
Jones & Laughlin Steel Corp. 97
Jones & Laughlin Supply Co. 52

K

Kellogg, M. W., Co. 69
Kobe, Inc. 2
Koehring Company 117
Koppers Company, Inc., Bartlett-Hayward Div. 119

L

Lane Wells Co. 85
Larkin Packer Co., Inc. 7
Layne & Bowler, Inc. 204
LeRoi Company 145
Line Scale Co., Inc. 226
Link-Belt Co. 163
Lone Star Cement Co. 73
Lufkin Rule Co. 220
Lummus Co. 9-10
Lynch, F. W., Company 229

Mc

McCullough Tool Company 95
McEvoy Company 104-105
McKissick Products Corporation 159

M

Mark, Clayton, & Company 213
Marsh, Jas. P., Corp. 30
Martin-Decker Corporation 84
Mercoid Corporation 206
Mid-Continent Supply Co. 161
Mission Mfg. Co. 79
Moore, Lee C., & Co. 183

N

National Carbon Company, Inc. 186
National Radiator Company, Industrial Division 196
National Supply Company 39
National Technical Laboratories 61
National Tube Co. 115
Nordstrom Valve Company 141
Norris, W. C., Manufacturer, Inc. 1
Norvell-Wilder Supply Company 169

O

Oakite Products, Inc. 154
Ohio Injector Company, The 58-59
Oil Center Tool Co. 101
Oil Well Supply Company 121
Oshkosh Motor Truck, Inc. 3
Otis Pressure Control, Inc. 207

P

Parkersburg Rig & Reel Co., The 109
Patterson-Ballagh Division of Byron Jackson Co. 179, 227
Peerless Pump Div., Food Machinery Corp. 227
Penberthy Injector Co. 19
Petroleum Electric Power Association 200
Phoenix Manufacturing Co. 233
Pittsburgh Equitable Meter Co. 32
Precision Scientific Company 40

R

Rector Well Equipment Company 89
Reed Roller Bit Co. 91-92
Refinery Supply Co. 167
Regan Forge & Engineering Co. 214
Republic Steel Corp. 188
Ridge Tool Co. 230, 231
Rockford Drilling Machine Div. 232

S

Schlumberger Well Surveying Corp. 110
Shaffer Tool Works 156-157
Smith, A. O., Corporation 67
Spang & Co. 155
Sperry-Sun Well Surveying Co. 146
Squier, John P. 227
Standard Oil Co. of California 34
Standard Oil Company of New Jersey 134-135
Sun Shipbuilding & Dry Dock Co. 27

T

Thermoid Co. 218
Toledo Pipe Threading Machine Co. 190
Tretolite Company 137
Twin Disc Clutch Co 87

U

Union Carbide & Carbon Corp. 186
United States Steel Corporation 115, 121
Universal Atlas Cement Co. 153
Universal Oil Products Co. 25

V

Visco Products Co., Inc. 170

W

W-K-M Company, Inc. 177
Waldrip Engineering Company 192
War Assets Administration 11
Watson-Stillman Co. 6
Weatherford Spring Company 13
Wedge Protectors, Inc. 219
Whitney Chain & Mfg. Co., The 36
Wickwire Spencer Steel Co. 217
Wilson, K. R. 143
Wilson Manufacturing Co., Inc. 99
Wilson Supply Company 173
Wisconsin Motor Corp. 226
Worthington Pump & Machinery Corporation 139
Wyatt Metal & Boiler Works 65

Y

Young Radiator Co. 228
Youngstown Sheet & Tube Co. 35